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NEW YORK, APRIL 3, 1920

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PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL AND PUBLIC WORKS" and "CONTRACTING"

Vol. 48 NEW YORK, APRIL 3, 1920 No. 12

Storm King Highway

Construction of a three-quarter-million-dollar road about four miles long. Scenic and commercial route terraced in previously inaccessible steep rocky faces of two rugged mountains where vertical cuts 170 feet deep were blasted directly over the West Shore railroad tracks to secure a narrow roadway without bridges or tunnels 400 feet above the Hudson river. Design materially modified as work progressed to utilize conditions disclosed by construction developments. Drills installed on suspended platforms; operated by men on life lines. Cement carried up roadless cliffs on men's shoulders. Massive, high, retaining walls with deep foundations were necessitated by steep slopes and decomposed rock. Precarious conditions made handwork preferable to blasing in many places. Materials and supplies were sometimes delivered by very expensive stone-boat hauling.

The Storm King road, officially known as State Road No. 5498, is 4.03 miles long from West Point to Cornwall and its completion will save a detour of 12 miles now necessary in driving between these two points, thus filling an important traffic need at the same time that it will provide one of the grandest and most beautiful scenic routes in the country and afford an example of successful construction under excessively difficult, dangerous and costly conditions.

COST AND CONTRACTS.

The portion of the road considered in this description is being built at an estimated total cost based on the computed quantities of the contracts, plans and specifications, of $717,583. The impossibility of making accurate preliminary measurments at some locations and the unknown character of the rock to be encountered in the most difficult sections, have resulted in a large increase of some of the originally estimated quantities so that the ultimate cost of the work, including the preliminary surveys, may perhaps equal or exceed a total of $850,000, a very large proportion of which will have been expended on a section of the road about 2,000 feet long located on the nose of Storm King Mountain.

STORM KING, SHOWING LOCATION OF HIGHWAY.

The work was designed and its construction is directed by the New York State Highway Commission—Frederick Stuart Greene, commissioner; James H. Sturdevant, division engineer; E. J. Howe, resident engineer in charge of construction, and Theodore Fenner, assistant engineer at the site.

The execution of this work has long been planned and although two successive contracts were let several years ago, no work was accomplished until after July 30, 1915, when a contract was awarded to the John L. Hayes Construction Co., Yonkers, who executed about $264,000 worth of work before the difficulties and interruptions due to war conditions and subsequent legislation caused

the cancellation of the contract on May 23, 1919. In July, 1919, bids were opened for the completion of the work, and the John L. Hayes Construction Co., being again low bidder, was awarded the contract at a unit price sum of $453,583, since which time work has been in active progress and it is hoped will be completed in 1921.

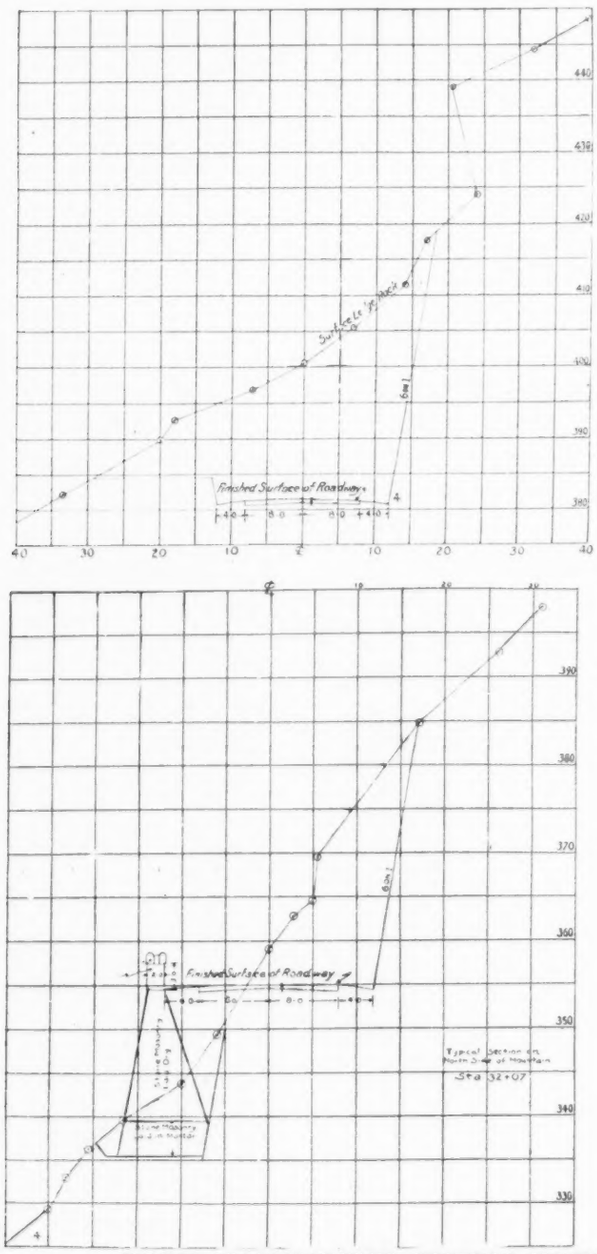
On December 1, 1919, the engineer's estimate showed that about 40 per cent of the total work had been completed and, the more difficult parts having been well advanced, it is expected that the remainder of the work will be finished as rapidly as the weather and labor conditions permit, the situation being so exposed and the climate so rigorous that only a small proportion of the work can be done during the winter months.

While construction was in progress on the first contract awarded, the work was illustrated in the *Municipal Journal,* Aug. 23, 1917, volume 43, page 169, where the general conditions and preliminary operations were described at greater length than in the present article. At that time work on the very steep rock slopes was usually commenced by drilling and blasting a line of jackhammer holes across the top of the cut to form an initial narrow bench or terrace. This operation was repeated down to an elevation 15 to 25 feet above grade. Afterwards the cut was widened by blasting successive rows of holes, the first of which was spaced far enough back from the face to insure the shattering of the rock with minimum displacement, thus forming a buffer that retained the material excavated above it so that it was available for use in fills.

GENERAL DESCRIPTION.

The road is at the north end of the famous Highlands and follows the west bank of the Hudson river where the width of the latter is from 3,000 to 4,000 feet, and the famous aqueduct tunnel carries New York's water supply through the solid rock under the river from Storm King to the east shore of the river at a depth of more than 1,100 feet below sea level.

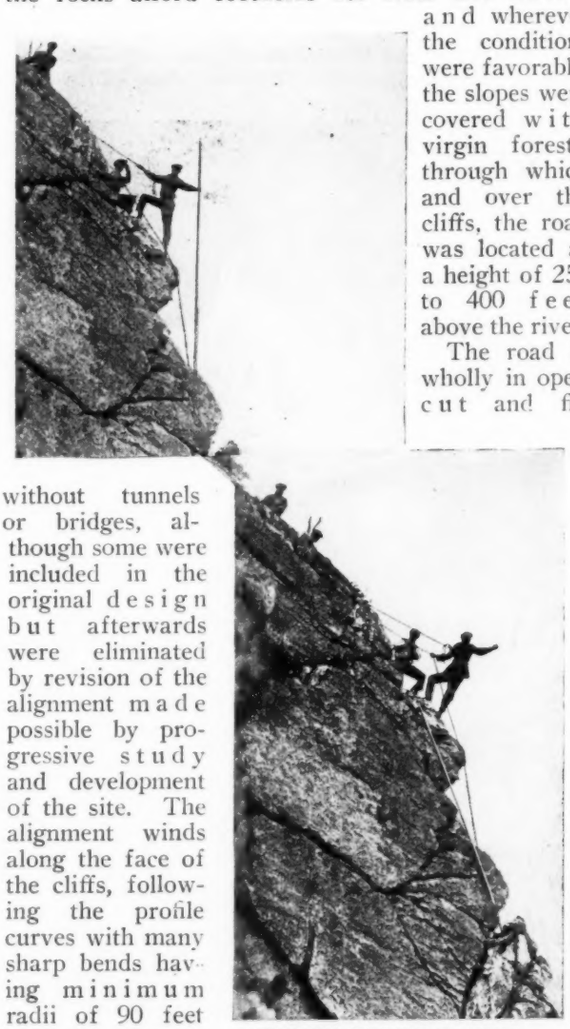
The road is located on the precipitous flanks of the adjacent Storm King and Crow Nest mountains, which rise to a height of 1,400 feet above the surface of the river. The faces of these mountains consist chiefly of a sort of bastard granite of extremely irregular and shattered stratification with dips and veins at all angles from the horizontal to the vertical. The surface of the rock is occasionally badly weathered and decomposed, causing slides on the river front and in the steep ravines, especially in the winter, when the ice pressure forces off great masses, and in the spring,



THREE CROSS-PROFILES, SHOWING ORIGINAL SURFACE AND FINISHED ROADWAY.

when freshets undermine and wash away large quantities of material.

Small amounts of earth and debris that have accumulated on the shelves and in the crevices of the rocks afford footholds for trees and shrubs and wherever the conditions were favorable, the slopes were covered with virgin forests, through which and over the cliffs, the road was located at a height of 250 to 400 feet above the river.



SURVEY PARTY TAKING CROSS-SECTIONS.

The road is wholly in open cut and fill without tunnels or bridges, although some were included in the original design but afterwards were eliminated by revision of the alignment made possible by progressive study and development of the site. The alignment winds along the face of the cliffs, following the profile curves with many sharp bends having minimum radii of 90 feet and with alternating grades up to a maximum of 7 per cent.

The plans and specifications call for a minimum width of subgrade in cuts of 24 feet, and 26 feet for the tops of embankments. The location was determined so as to promixately equalize the yardage in the excavations and in the embankments, but so much material was lost in building on steep slopes, even with the most careful kind of blasting, that it has been necessary to procure a considerable amount of embankment material from borrow pits with a maximum haul of about 1,200 feet.

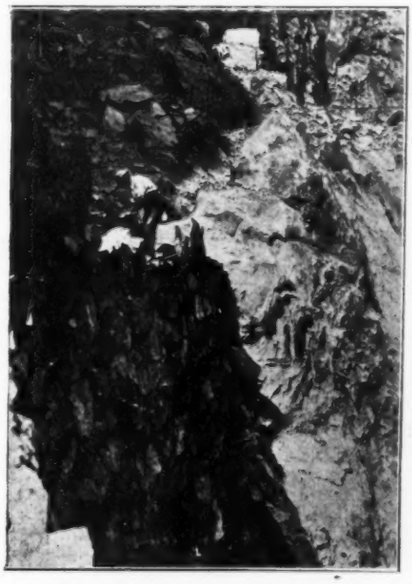
ENGINEERING CONDITIONS.

On account of the unusual conditions and great difficulties and expense of construction, the engineers were allowed exceptional latitude in the final location, thus giving the road a considerable flexibility and enabling considerable reductions in the amounts of work by comparatively slight deflections of the road, as the actual construction work developed new or unsuspected conditions whereby cost might be increased or diminished according to the position.

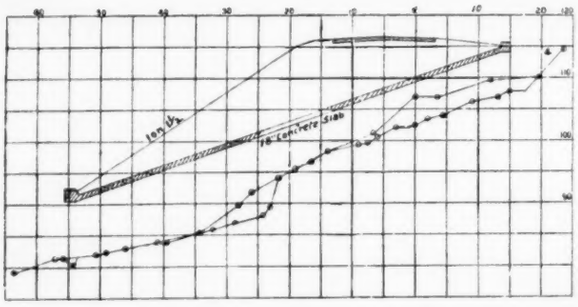
Ordinarily the location was only shifted a few feet transversely, but notwithstanding the exercise of the greatest care and judgment, some of the final quantities necessarily involved in the construction were three times as great as those of the original estimates. Irregular stratifications, steep slopes, the decomposition due to weathering of the surface and to the penetration of rain, snow, and ice in the crevices and the occurrence of many inclined veins, some of them filled with quartz and some with soft material, made the condition of the rock on the surface and for depths of sometimes 10 or 15 feet especially dangerous, uncertain, and costly to handle.

CHANGES DURING CONSTRUCTION.

When excavation was actually commenced, the conditions were sometimes found to be much different from what the original survey and inspection had indicated, and the excavation often proved to be deeper and much more costly than anticipated. More accurate information regarding the character of the rock showed that parts of the original alignment and structures could profitably be modified in some important cases. In one place early developments permitted the elimination of a bridge of about 200 foot span, the necessity for which was obviated by carrying the road through a cut that was not at first considered practicable. In another place a difficult and expensive cut was substituted for a short tunnel section because it became evident that the character of the rock was so treacherous that great danger would be involved in an attempt to excavate the tunnel, the stratification and dip justifying the fear that the roof and walls of the tunnel might slide bodily forward into the tunnel; a possibility that was confirmed by the experience of acqueduct engineers and their observations in the construction of a tunnel deep under the river bed at a point not far distant, where the same characteristics of rock were observed.



MASON LAYING RETAINING WALL.



CROSS-SECTION OF CULVERT ON STEEP SLOPES.
The concrete slab shown forms the top of the culvert.

EXCESS EXCAVATION AND MASONRY.

In many cases where a comparatively small amount of excavation would have sufficed for terracing the road bed on the slope if the latter had been composed of sound, stable rock, it was found necessary to remove not only the loose rock, but some of the ledge rock to a distance of 10 or 15 feet or even more in direction perpendicular to the slope, and for a long distance parallel with the slope, to secure stable conditions. In other cases the removal of the rock directly involved in the proposed cut left large masses of ledge rock in a more or less unsound condition overhanging the roadway on account of the blast and cleavage having followed the inclined strata and the removal of these threatening masses involved an unexpectedly large amount of material sometimes extending up the mountain side to a considerable height.

It was usually necessary to protect the river side of the roadway by a massive retaining wall, of gravity section, from 20 to 50 feet high. The foundations of these retaining walls were always carried down to horizontal or offset footings in the rock, sometimes at a depth of 10 or 20 feet below the surface, and involved another large amount of difficult excavation, much of which could not be anticipated in the original estimates.

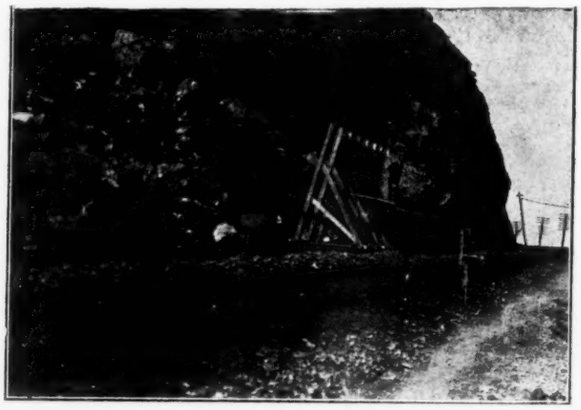
All of these conditions prevailed to increase the amount, difficulty and expense of excavation, especially in some of the cuts which attained a maximum depth of 170 feet in extreme cases where they followed the very steeply inclined surface of the rock and necessitated the removal of a comparatively thin mass of material approximately parallel to it.

SPECIAL EXCAVATION METHODS.

A large portion of this rock consisted of detached masses with dimensions up to 10x15x25 feet and loose boulders up to 25 tons weight. These were block-holed with jack hammer drills and blasted with great caution so as merely to split them up with a minimum displacement. In many places care was taken to lift the shattered rock from its original position and carefully deposit it in a stable position on the slope by means of derricks rather than permit it to fall down the mountain side. So far as possible, a narrow shelf or terrace was first provided, the face of the cliff blasted, and the shattered rock received and retained on the shelf until it could be moved to a safe position or placed in walls by the derricks.

TRACK PROTECTION.

In many places, especially for a considerable distance on the face of Crow Nest mountain, nearly all the rock that rolled down the mountain was likely to fall onto the double tracks of the West Shore Railway located on the river bank close to the surface of the water. Great precautions were therefore taken to safeguard the railroad and traffic; the tracks were constantly patrolled and telephone stations were established communicating with the



BARRIER TO KEEP STONES OFF OF RAILROAD TRACK.

working parties on the mountain sides above, with the engineer's offices, and with the train dispatcher's office, and blasting was not allowed except at times designated by the railroad authorities when no trains were allowed on this section of the track.

It was at first required that the contractor should maintain a locomotive derrick on the tracks ready to remove obstructions immediately should they occur, but it was found that getting the derrick car on and off the main lines of tracks took so much time that the obstruction to the traffic was greater than that which was due to removing the rocks by hand, and the derrick car was therefore superseded by hand work. Care was also taken to use still smaller charges in blasting the rock above the tracks so that there was less danger of large quantities of rock falling on the tracks.

SAFETY BARRIER.

At one of the worst places the track is protected, as required by the contract and specifications, by a wooden barrier built between it and the foot of the cliff. This barrier is virutally a vertical bulkhead about 20 feet high and 140 feet long, made with 2-inch horizontal planks, spiked to vertical posts about 4 feet apart, which are strongly framed to horizontal sills and double inclined braces, somewhat faintly shown in the photograph. This barrier was built as close as possible to the track beyond the ponts where the large stones falling from the mountain sides struck the ground at the bottom of the cliff, and served a useful purpose in preventing most of the bounding and ricochetting pieces from striking the trains or falling on the tracks. In some cases, however, stones broke through the planks and sometimes even destroyed the heavy timberbents.

Just above this point, on one occasion, a piece of rock weighing about 600 lbs. was blasted from the cliff at a height of about 300 feet above the

tracks and was thrown 1,200 feet horizontally, falling squarely on top of a telegraph pole.

CLASSIFICATION OF COSTLY WORK.

Under such conditions the contractor and engineers wisely preferred to loosen and displace as much of the rock as possible by barring without blasting. The difficulty and expense of the work was recognized in the specifications, where special classification of rock is made and three different prices are permitted according to the locality in which the work is done. In one section of the highway 100 feet long, there will be excavated 14,000 yards of rock at a contract price of $6 per yard, which is believed to afford the contractor little if any net profit.

END VIEW OF A RETAINING WALL.

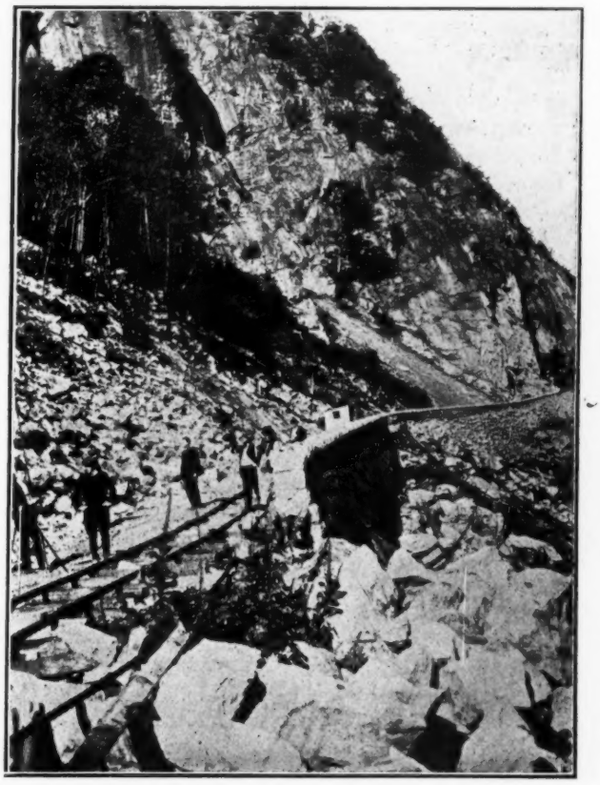
Up to the present time it has been possible to make advantageous use of a steam shovel for excavation at only one point, accessible from the south of the road, where a steam shovel was brought in at grade and excavated 25,000 yards out of 35,000 yards total. Between stations 65 and 68, a very heavy fill was required, about 20,000 yards of which had been derived from the adjacent cuts before Nov. 1, 1919. This work was commenced in 1917 and on June 5 a steam shovel was located in a borrow pit nearby delivering materials to skips on service cars that were dumped by a derrick installed at the top of the fill. On Nov. 1, 1919, 36,000 yards of material had been placed in the fill and 10,000 yards more were required.

DELIVERY OF MATERIALS.

At the commencement of construction operations, no part of the location was accessible by wagon roads except a short length at each end where trucks with moderate loads could be hauled to grade, and at one intermediate point between the two mountains where it was possible to haul very light loads over a long route from the nearest road on the high land west of the highway. The rest of the alignment was so inaccessible that in many places it was almost impossible to make the preliminary inspection and survey and the daring engineers were obliged to let themselves down the almost vertical slopes of rock by means of ropes attached to their belts. They were provided also with hand lines and ladders and required extra long levelling rods to secure readings on inaccessible points. Notwithstanding all of their precautions, one man fell from a great height on account of the breaking of his safety rope.

In order to expedite the work by commencing it at intermediate points, there were eventually located or developed three footpaths or trails from the water's edge to grade and on two of them it was possible to haul stone boats drawn by horses or mules.

For a considerable distance, especially over these paths, such light plant and materials as were indispensable were hauled to the roadway at great cost. Bags of cement were carried down the river and stored near the water's edge. In one place where two mules could be used they hauled loads of three to five bags placed on stone boats and in another place where only one animal could be used the load consisted of one to three bags. Where no animals could be used, half and quarter bags of cement were carried upon men's shoulders, thus making



ROUGHLY GRADED ROAD, RETAINING WALL, AND PARAPET WALL EXTENDING IN THE BACKGROUND.

the cost of delivering cement from the water's edge to the highway frequently five times as great as the original price paid to the manufacturer.

In some places sand was delivered in the same way as cement, and consequently every effort was made to utilize all deposits of suitable sand found near the grade and the engineers facilitated the work as much as possible by liberal decisions regarding the acceptability of the sand as determined by field tests.

INSTALLATION OF PLANT.

The contractors succeeded in installing two 20 h.p. steam boilers and four hoisting engines, two of them operated by compressed air, at intermediate points of the work and also delivered there five wooden derricks, one of them being operated by a hand windlass. Steam coal delivered by stone boats cost about three times as much at the job as it would on accessible work.

The use of an aerial tramway was investigated and estimates showed that a cableway about 1,200 feet long, to serve one of the more inaccessible portions of the line, would cost about $2,000 and the expense of installing it and moving it several times from position to position as the work advanced would be prohibitive. The idea was therefore abandoned and plans have been made for a gravity service road to handle spoil and concrete, by which the loaded cars will go down the incline by gravity and be hauled back empty or full by a hoisting engine.

DRILLING AND BLASTING.

A steam driven Ingersoll air compressor with capacity of 2,600 cubic feet of free air per minute has been installed by the contractor at the old shaft used for the construction of the water supply tunnel under the river. Air at 95 pounds is delivered through a 6-inch main laid alongside the West Shore railroad track from end to end of the section, and with its 4-inch and 2-inch extensions and branches has an aggregate length of six miles of pressure pipe. This delivers air to the work at a reduction of only about 5 pounds from the 90 to 95-pound pressure automatically maintained at the station. As the branches are carried up the mountain side on a very steep slope, no difficulty is experienced from condensation water collecting or freezing even in the coldest weather. Simple, effective traps have been secured by the insertion of short lengths of 6-inch pipe with blow-off valves to dispose of any water collecting in the line.

From a small dam built by the contractor far back in one of the ravines, water is delivered along the line in a 1-inch pipe that provides amply for the consumption of about 160 barrels daily.

The air supply is considered sufficient for 40 jackhammer drills, provided no other use is made of it, but a considerable amount is required for the operation of the hoisting engines and drill sharpeners, enough, however, remaining for the 10 to 20 jackhammers that are used to the exclusion of tripod drills. The jackhammers are found very efficient, and drill holes to a depth of 10 feet without difficulty and to a depth of 16 feet when necessary. These drills are operated in many cases by men working on painters' scaffolds suspended on the face of the very steeply inclined or even vertical cliffs and reached by ladders.

MASONRY AND CONCRETE.

The retaining walls, of which there will be about 10,050 lineal feet, containing about 26,800 cubic yards, are chiefly made of rubble masonry laid dry with footings of masonry laid in cement, and are 2 feet thick at the top at grade, with the outer face battered 1 on 6, and the inner face battered 1 on 3. Their height varies from 5 to 50 feet and they are surmounted by a parapet wall 2 feet thick and 3 feet high, with rustic coping, which is made of large stones laid in cement mortar. The walls are carefully built with stones up to 2 yard size handled by movable stiffleg derricks equipped with steam, and air driven hoists. In some places the spaces were so narrow that the derrick sills were supported at one end on the top of the wall and at the other end on the face of the cliff.

Some of the retaining walls with a 1 on 12 batter are made of rubble masonry laid in cement and all of the culverts, which have dimensions up to 10 feet wide and 15 feet high, are made with cement masonry walls covered with roof slabs of reinforced concrete. Concrete is also used for face walls at both ends of the culverts. Many of the culverts are built on inclines sometimes sloping as much as 45 degrees from the horizontal.

PROGRESS UNDER DIFFICULTIES.

Construction is now being carried on at both ends of the road and at four intermediate points, involving a force which has at times reached a maximum of about 150 men, but during last season averaged about 100 men, who were experienced on this job and worked with confidence and considerable efficiency under the very difficult conditions. Most of them are of American birth and it is significant that they refuse to work with men that fail to exercise proper carefulness.

In very hot weather the sun is reflected from the surface of the water and from the face of the mountain and the heat is so intense that it is sometimes impossible for the men to work after 9 o'clock in the morning.

In the winter the cold is sometimes extreme, the winds are strong and the steep rocks very slippery from snow and ice, so that work is suspended in many parts of the line, although some sheltered portions permit excavation and draining to be carried on practically without interruption. Most of the work is exposed to very high winds and in one place between the two mountains, where it was anticipated that the Storm King mountain would prove an effectual shield for the fierce north winds, it was found that these winds were deflected against the face of the Crow Nest mountain and produced equally strong winds from the south.

Considerable of the difficulty experienced was due to the springs and small streams encountered, and pains were taken to drain them to avoid the danger and inconvenience of water collecting in the excavations, and particularly to prevent the formation of large icicles liable to fall without warning at any time with possible fatal consequences. All of the retaining walls are pierced at intervals of 10 feet with 4-inch tile drain pipes providing weep

holes to prevent the accumulation of water behind the walls.

The principal quantities involved in the total work include:

Earth and loose rock excavation	129,561	Yards
Ledge rock excavation	100,840	"
Masonry—parapets, culvert walls, etc.	4,748	"
Masonry—retaining wall laid in mortar	8,252	"
Masonry—retaining wall laid dry	18,552	"
Special guard railing	9,720	Feet
Macadam, including top and bottom courses	6,450	Yards
Bituminous Material	77,200	Gallons
Protection of West Shore Railroad property	$19,076	

Maintenance of Public Highways

The effect of each kind of construction or resurfacing on the future cost of maintenance should be studied in advance. Foundation and wearing surface should both be adapted to the traffic which the road will carry—which is not necessarily the present traffic.

By Clarence D. Pollock

It is well to ponder carefully the remarks of Col. William D. Sohier of Massachusetts at the meeting of the American Association of State Highway Officials at Louisville, Ky., recently. He stated emphatically that the older literature on highway construction would answer many of the questions which were apparently being newly raised. Col. Sohier's remarks also apply to many street paving matters which are being brought up again.

UNECONOMICAL TREATMENT OF OLD BLOCK PAVEMENT.

In this connection it is curious to note the tendency at the present time of some of the newer paving and road engineers to experiment with surfacing old brick and stone block pavements with bituminous materials of one kind or another. The older paving men will readily recall the resurfacing of old block pavements twenty to twenty-five years ago. About 1896 and 1897 the old city of New York went wild over this method when sheet asphalt pavements were laid at a very low cost. No thought was taken of the cost of maintenance, but the whole idea was to lay a big mileage of smooth pavements. This gave a great yardage at a low first cost, but it was not long before the maintenance cost was large. The foundation was not sufficiently stable even for the traffic of that period and a great point of weakness was in the matter of openings. There was no chance to bond the foundation over the opening, with the adjacent foundation. Settlements inevitably developed over the cuts and the adjacent foundation would also sink towards the sunken patch. This burying of the old material not only provided a poor foundation, but was also a waste of usable old material in most cases.

If the old pavement consists of granite blocks, the blocks can usually be recut and paved on a concrete foundation, making a first class heavy-traffic pavement at a considerable saving over new blocks. If the blocks are not fit for recutting, they may be crushed for broken stone for the concrete foundation, as is true of other stone blocks. In the case of an old brick pavement, the better bricks can be culled out and used in side streets. Even if an old stone block or a brick pavement has a concrete foundation underneath, it makes a poor foundation for a bituminous surface. When a cut in the pavement is made, the middle layer of the sandwich is loose and affords no bond for the foundation placed in the cut and settlement will surely occur around the edges of the cut.

MAINTAINING STATE HIGHWAYS.

In constructing the great mileages of State highways, far too little thought has been given to the maintenance of these road surfaces. The main idea has been to lay mileage and cover the greatest amount of ground without thought as to the future. This has resulted in the laying of great lengths of unsuitable pavements which soon are destroyed under the severe traffic and must be reconstructed at the end of three to four years in many cases. Sometimes these short-lived pavements have been paid for by 50-year bonds. It would be far better to lay a much less mileage upon a substantial concrete foundation. Then this base could be regarded as the permanent portion of the pavement and the surface the temporary sheathing, which should be of such material that it will stand the traffic to be expected for a resonable period.

With the great amount of state road surfaces already constructed of materials which are only suitable for very light traffic, it will be necessary to have extensive organizations for maintaining them properly. There is nothing to which the old saying that a "stitch in time saves nine" applies more than to road surfaces and pavements, and yet it is so often neglected. A road surface is allowed to go until it is often necessary to entirely resurface it to put it into passable condition. There is no economy in this.

One trouble has been that the roads in many cases have been constructed of material that might have been suitable for the present traffic in its bad condition, forgetting that much greater traffic will be attracted to the road after it has been improved. While in many cases it will be better to rebuild present improved roads as soon as the money is available in order to have a material which will be economical to maintain; yet in many other cases a proper organization to patrol and repair the present surfaces promptly when signs of wear first appear will be absolutely necessary in order that the maintenance cost may be kept within reasonable limits and traffic may be carried with moderate maintenance cost on the vehicles used. It must be borne in mind that the excessive cost of repairs to the road when its maintenance has been neglected is only part of the cost to the public, as the bad condition of the road pavement is quickly reflected in

the cost of wear and tear and accidents to the vehicles using the highways.

ADAPT FOUNDATION TO TRAFFIC.

While desiring to emphasize the importance of building a good foundation for all state roads having heavy traffic, we do not wish to be misunderstood as to the necessity of this in all cases. Of course there are many roads where the traffic may be heavy in number of vehicles, but the unit loads may be light. In many such cases it is not necessary to go to the expense of a concrete foundation, but broken stone or the like may serve sufficiently well. However, the organization should be large enough and have sufficient engineers of experience in it, so that proper study may be made of each road before the material is selected. In this way excessive maintenance costs may be saved. In the past the work of most of our states has been carried on by much too small a force of engineers and consequently it was impossible to make a study of the conditions surrounding each road. With the large amounts to be expended on highways in this country during 1920, together with the shortage of labor and cars for transportation of materials, it is especially important that careful studies be made before letting contracts, as mistakes will involve much greater waste of funds than formerly.

FIT THE BOND TO THE ROAD.

It is pleasing to note that the state highway commissioner of Pennsylvania has ruled that the counties cannot use money from longtime bond issues for anything except the more permanent types of pavement on the state and county highways. The old methods of paying for water-bound macadam and the like by 50-year bonds, as has been done in New York State, is very expensive and wholly wrong—it soon becomes paying for "dead horse" with a vengeance. Funds from long-term bonds should be used only for constructing the more durable types of roads. The pay-as-you-go policy is the correct one for the lighter forms of construction which may be suitable on the secondary roads.

ROAD MAINTENANCE ASSOCIATIONS.

It is a noticeable fact that associations of all kinds have been formed to push certain roads and trails and to obtain money for them, but their efforts then cease. There would seem to be a big undeveloped field for civic associations to follow up the maintenance of these roads after obtaining them. We would suggest the desirability of providing an adequate maintenance fund at the time of securing the construction fund, especially in cases where the highway is to be in the nature of a memorial. In this way the memorial could be put on a permanent basis and besides, the providing for the future maintenance would be likely to compel more careful consideration of the materials to be selected in its construction in order that the maintenance fund should be ample to keep the road surface in good condition continuously. In other words, it is likely that, with a definite maintenance fund provided, it would insure a more careful engineering study of the conditions affecting the road before deciding upon the materials to be used in its construction.

Concrete Plant in Old Canal Bed

A dry canal bed at Nashua, N. H., was very efficiently utilized by the Aberthaw Construction Co., Boston, for the installation of a concrete plant and the apparatus for unloading, storing and transporting aggregate and cement for the construction of a large reinforced concrete factory. Advantage of the location was taken to secure an ingenious arrangement that provided for the very convenient and rapid unloading of materials and for handling them largely by gravity in a manner that greatly expedited the work and reduced the cost of mixing about 25,000 yards of concrete.

The aggregate bin 21 feet wide, 9 feet deep and 84 feet long, was built with a horizontal bottom about 9 feet above the canal bed and the top at street and track level, permitting trucks in which the sand was delivered from a local supply, and the cars in which the broken stone and cement were delivered, to be run over the tops of the bins where two longitudinal standard gage, full length tracks were installed and a slightly inclined ramp transverse to them for the sand tucks which thus delivered directly to the sand compartments occupying the center portion of the bins, the ends of which were used for stone storage. Stone is dumped from the cars into the open tops of the bins and sand is dumped from the trucks in through an iron grating covering the top of the sand bin.

Between the tracks on top of the bin there is installed, 6¾ feet above them at a convenient height for handling the cement bags from the car floors, a gravity conveyor, parallel to the tracks, that runs through the cement storage house and terminates on the charging platform over the concrete mixer, thus providing for the unloading, storage and direct delivery of cement.

Cement and sand are discharged by gravity through four 12 x 15-inch gates in the horizontal bottom of each bin, which are arranged in pairs so that both sand and stone gates can be operated simultaneously. The sand and stone are delivered into a measuring hopper, with two compartments giving the required amounts for one batch, that is moved from end to end of the bins on a track underneath them by means of an electric hoisting engine and cable.

The measuring hopper delivers into a charging car running on a parallel track beneath it, on the bend of the canal, which is hauled back and forth and up an incline by an electric hoist. It discharges into the charging hopper of the concrete mixer which is also served by a chute delivering cement from the platform above.

Concrete is mixed in two four-bag Ransome machines that discharge into chutes delivering from opposite sides into ordinary V-shape dump cars on an industrial track on the canal bed.

Four-car trains of concrete are hauled by a gasoline locomotive on a service track running to the three hoisting towers, one in the middle and one at each end of the building. Each train delivers

two cars to each of two towers, while another train is being loaded and the locomotive is then switched across to the back track and brings back the empties, returning again for the next trip with full cars and so on. From the hoisting towers the concrete was spouted directly to the foundation piers and heavy retaining walls and to nearby portions of the superstructure, the more distant parts of the latter being served with concrete buggies operating from distributing hoppers on each floor.

Road Construction in Chatham County, Georgia

Three large contracts are now under construction, each for a concrete road. All three contractors use the same make of mixer and two use mechanical loaders. Two also use mechanical finishers. One hauls by mule teams, one by trucks and one by gasoline engine on construction track. The county and city are building a memorial road by day labor.

One of the first counties in the Southern States to start its 1920 road work was Chatham County, Ga., of which Savannah is the county seat and only large city. This county at present has under construction three contracts, one on each of the highways known as the Fort Wentworth road, the Ogeechee road and the Lewisville road, which are to be paved with concrete laid on the old shell or gravel surface. In addition, there is soon to be let a contract for the Tybee road, which will total 16 miles with 2800 lineal feet of bridges, which include three draw-spans, the estimated cost of this improvement being about $900,000.

The three roads now under contract lead from Savannah to the county line. The entire country is very flat and quite low, but the drainage of these roads had already been provided for during the earlier construction and improvement work. The Tybee road will lead from Savannah through the low lands and islands between that city and the ocean.

The Port Wentworth road is 15 miles long, eight miles to be paved 20 feet wide and the remainder 16 feet. The cost will be about $570,000. The Ogeechee road is about 12½ miles long and will be paved 16 feet wide. The plans provide for three concrete bridges of 60 foot, 70 foot and 80 foot span, respectively. The estimated cost is $450,000 The Lewisville road improvement is about 13 miles long, about 3¼ of it being built by Federal aid and 18 feet wide and the remainder, to be built entirely by the county, is 16 feet wide. The former is estimated to cost $111,736 and the latter $410,308. There are no bridges on this road.

Each of the roads is being surfaced with 1-2-3 concrete uniformly 6 inches thick, the sub-grade being given the same crown as that required for the surface; except that the 20-foot section of road is 8 inches thick. Granite is used for the coarse aggregate, being the only material available. In each case, the old road which is used as the subgrade is shaped up and rolled solidly immediately

LOADING CONCRETE MIXER ON CHATHAM COUNTY WORK.
The mixer is shown at the left. At the right is seen the loader, consisting of a belt conveyor carried on a trussed car.

in advance of the concrete construction. Expansion joints are placed 50 feet apart, "Elastite" being used in these joints.

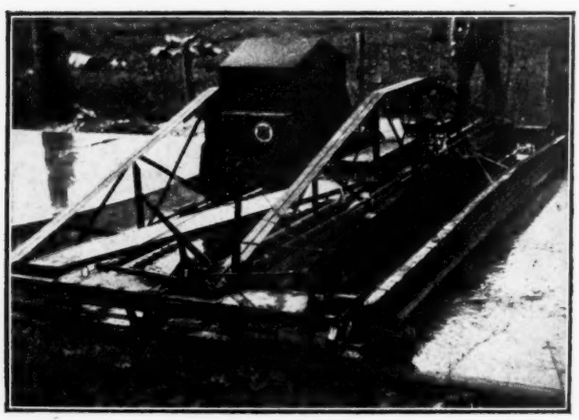
CONSTRUCTION METHODS.

The pavements being laid on these roads are similar in all respects, except for the differences above noted, and there is also considerable similarity in the methods and appliances used by the several contractors. The Port Wentworth road is being constructed by the Dixon Construction Company; the Ogeechee road by W. T. Hadlow of Jacksonville, and the Lewisville road by the Lawrence Construction Company of Augusta.

Each of these contractors uses a Koehring concrete mixer, and two use a Koehring loader instead of wheelbarrows for bringing the aggregates to the mixer. Also, each of the contractors brings his aggregate to the nearest point by cars and unloads it from the cars by means of a crane.

For transporting the aggregate from the railroad siding to the work, however, each employs a different method. For the Port Wentworth road, the Dixon Construction Company uses wagons hauled by mules, the maximum length of haul being four miles, there being a number of sidings available a comparatively short distance from the road. The contractor for the Ogeechee road uses an industrial railroad with two-foot gauge. The cars are hauled by a gasoline engine, the aggregate being carried by them in batch boxes which are filled by the crane at the siding, each box holding measured aggregate sufficient for one batch, and being dumped into the skip of the concrete mixer directly from the cars. The maximum haul on this contract is 6 miles. The equipment used on this work by this contractor is said to have cost about $75,000. The Lawrence Construction Company does its hauling by trucks, using a number of these, mostly of the Garford and 4-Wheel Drive Auto Company make.

For finishing the concrete surface, the Dixon Construction Company uses a hand roller followed by a length of garden hose dragged over the surface, which is said by the county engineer to give an excellent finish, better than the use of a belt. W. T. Hadlow and the Lawrence Construction Company used Lakewood finishers; also Blaw-Knox forms for the concrete, the finishing machine running upon these as a track.



FINISHING CONCRETE PAVEMENT BY MACHINERY.

After completion, each of the roads is protected from the sun by canvas supported on a frame until the surface has hardened, when it is covered with 1½ inches of dirt which is kept wet. Eighteen days after completion the dirt is removed and the pavement thrown open to traffic. The contractors have to obtain water for mixing concrete and moistening the earth by sinking wells, except at occasional points where they can obtain it from public water supplies. These wells are sunk 500 or 600 feet deep, ordinarily about 4 miles apart so that water can be provided to all parts of the work by pumping through a length of pipe not exceeding two miles. Two-inch pipe is ordinarily used for carrying the water from the well to the work, T's being inserted in this at intervals to permit hose connections.

Payment for the concrete work is made by the square yard, including the concrete surface only. The two last contracts let went for $2.68 and $2.84 respectively, but so far as known no contract has been let in the State of Georgia this spring at less than $3, and the prices are rising considerably above this. The preparation of the old road, which is done by scarifying, shaping up and rolling, is paid for additionally by the square yard.

MEMORIAL ROAD.

In addition to the roads mentioned, the county is constructing by day labor a memorial road, to be dedicated to the memory of the men of the county who fell in the World War. The county is completing about two miles of this road and 1,800 feet additional is being constructed by the city, this being an extension for this distance within the city limits. This road consists of two drive-ways with a parkway between them, which parkway will be sodded and contain two rows of palmettoes. Near the mid-length of the road will be a circle, in the center of which will be erected a monument of stone carrying bronze tablets. The construction of the road will be paid for by county and city funds, but the monument is to be paid for by money raised by popular subscription, nothing more than $5 being accepted from any one person. The cost of the monument will be about $20,000. The county bond issue contains $105,000 to be used for this road. At present the county work on the road consists of filling in across a low spot several hundred feet wide and light grading on the balance of the road. For this purpose the county is using, as a construction railway, an old street railway track which was purchased by the county in order to remove the railway from the memorial highway, one rail of the track being moved in so as to narrow it to the gauge of the construction engine and cars. A part of the force used in this construction is convicts.

In this connection, we were informed that the county highway and drainage work was suffering considerably from the lack of convicts to be used as laborers. Prior to last July they could always count on 500 or 600 convicts available for this use, but the supply has now fallen to 100 to 125, including women. Owing to the fact that most of the

convicts are negroes, and that free negroes cannot be relied upon to work many days in succession, while convicts can be kept at the work six days a week, the county authorities consider one convict to be the equivalent to two free negroes, if not more.

For the above information and for courtesies shown in a visit in this work, the writer is indebted to W. F. Brown, county engineer, to Judge Oliver T. Bacon, chairman of the County Commissioners, and to G. Reuben Butler, clerk of the Commission.

Repairing Docks in Mexico

U. S. Commercial Attaché Edward F. Feely reports from Mexico City that the ministry of communications and public works is making a study of the needs of docks, piers and similar structures in various ports of the Republic, some of which, notably at Salina Cruz and in ports of Lower California, are in defective condition. It is proposed to obtain an appropriation of 400,000 pesos for the work, and Salina Cruz will be the first port to receive attention.

The Paving Problem in Japan

By Prof. T. Takakuwa *

Japanese streets, until recently used only for light, slow traffic, are mostly dirt roads, with a small amount of gravel surface. Increasing commerce and industry and advent of numerous automobiles necessitate much immediate paving. Bituminous and concrete surfaces have very promising future and require heavy importations.

I may say that at present we have almost no paved roads at all in Japan. Even the city of Tokio, the capital of Japan, has only a few miles of paved streets and this circumstance is due only to an experiment which was made several years ago. The cities of Osaka and Kobe are in the same condition.

FEW GRAVEL ROADS AND UNIVERSAL MUD.

All of the highways in Japan, the streets and country roads, generally, consist of poorly constructed gravel roads, this gravel being easily obtained from the many rivers running through the country. Thus it is quite clear that such roads get very dusty in dry weather and very muddy in wet weather

In January of last year, *Good Roads* explained fully the present Japanese roads in describing the visit of Samuel Hill, former president of The American Road Builders' Association, to Japan. The description reads as follows: "Japan figuratively speaking, lies within the realm of King mud. For nine months of the year the roads are endless lines of seemingly bottomless ooze. Only in the seaport cities, pavements are to be found. Everywhere else is mud and mud."

I am sorry to say that we must unwillingly recognize this candid description as a fact, in part. These bad roads throughout the country are the constant cause of innumerable disadvantages and supreme discomfort to our people and also are a constant wonder and annoyance to the foreigner who visits Japan.

EXPLANATION OF ROAD CONDITIONS.

What is the reason for such a condition being permitted to exist in Japan even up to the present time? There are three principal reasons which I may mention and which are as follows:

Firstly, I think it might be said without the slightest hesitation that the unconsciousness and indifference of our nation as to the benefits and advantages of establishing good roads, comprise one of the principal reasons of the present road conditions.

The second reason consists in the fact that all municipal improvements in Japan are far behind those of the Occidental world, that is, around two or three decades. Therefore, not only the road system, but many other municipal improvements necessary in Japan, are still in their embryo.

The third reason, though of minor importance, is that: Light and slow-speed vehicles constitute most of the traffic in Japan, the principal means of transportation on the road being the one-horse carriage which carries about a one-ton load and the light carriage drawn by men. We have very seldom such heavy traffic as to necessitate the use of two or more horses, as in this country, moreover, automobiles have been very little in use until quite recently. So, in spite of the inferiority of our roads, they have been able to bear up under the lighter traffic of the past.

IMPORTANT DEVELOPMENTS IN PROGRESS.

But during the past few years, in consequence of the speedy development of business industrially and commercially, the amount of traffic has constantly been on the increase. Especially, the great number of motor vehicles and heavy motor trucks which are being imported into Japan every year, are constantly increasing. Moreover, in consequence of the increase of the labor cost, development of industries and trades, and the great expansion of our principal cities since the late war, there is, in Japan an ever increasing demand for heavier vehicles and motor trucks of various kinds. In my opinion, we shall in no distant future have more than 100,000 motor cars in Japan.

Such traffic increases will prove destructive in

*Of the Kiriu Technical College of Japan.

the extreme to our poor road system and ever since a few years back, they have, more or less, converted the city roads into a state of muddy ooze and dusty deserts. Thus, it is quite evident that our people are subjected to extreme annoyance on account of the poor condition of the road and the terrible dust caused by traffic in general. As a result, therefore, their own personal experience of discomfort has roused them to action and hence the improvements of our streets and the paving of the highways in Japan has become an exceedingly great problem to the public, generally.

NEW CITY PAVEMENTS PROPOSED.

After much discussion by municipal authorities, the city of Tokio and Osaka decided to lay down perfectly new pavements throughout the said cities, provided the central government granted the necessary subsidy, that is, one third of the amount required for the construction of the roads. Should the subsidy be granted, the work will commence this spring. Other big cities, as, for example, Kobe, Kioto and Yokohama are also in the process of deciding this all important question. Thus, as may be seen, the paving enterprise is growing rapidly and will develop into a big business in the near future in Japan.

TOKIO'S PROGRAM.

Tokio city proper has 600 miles of public road which covers an area of approximately 10,000,000 square yards, corresponding to nearly 11 per cent of the total area of the city, viz., 30 square miles. The plan which was recently decided upon by the municipal authorities of Tokio is as follows: Firstly, to pave within the next eight years, commencing from this spring, the principal main streets running through the city which have a width of 36 feet or more. This represents 167 miles of street and the actual area to be paved covers 4,400,000 square yards. After the completion of this plan it is suggested that all the remaining streets be paved at the earliest opportunity.

But, it seems that this plan offers no speedy relief, seeing that at the above rate it would take more than fifteen years to complete all the pavements of the city. Aside from this, we must bear in mind that the city of Tokio, besides the city proper, above mentioned, has an environment which covers an extensive and constantly increasing area representing twice that of the city proper, and will, in the near future, be annexed to greater Tokio. Considering the facts just mentioned it is my belief that it will in the near future, be possible to make up a plan along more speedy and progressive lines.

OSAKA'S PROGRAM.

The city of Osaka, which is the largest business and industrial city next to Tokio and has about 350 miles of public roads, estimating approximately 6,700,000 square yards, has lately decided also on a plan of improving the streets and the plan suggested appears in all instances to be a more progressive one than that contemplated by the city of Tokio. This plan is to lay down whole streets of the city with new pavement within the next ten years.

WOOD BLOCK AND BITUMINOUS PAVEMENTS PREFERRED.

The question as to what kinds of pavement would be most favorable to these cities, offers a most interesting and important feature for investigation. The municipal authorities of Tokio and Osaka contemplated adopting the plan of constructing bituminous pavements and wood block pavements throughout the greater part of the city. However, on account of the constant increase in the price of wood, which apparently will increase still more in the future, even more so than other articles, it will of a necessity follow that the laying out of wood block pavements will be limited to a certain extent. As a consequence, then, bituminous pavements, i. e., sheet asphalt and bituminous concrete pavements will more and more come into general use in these cities of Japan.

Bituminous paving materials, both of the mineral aggregates and the bituminous substances, are produced in Japan to some extent but the latter is not sufficient in quantity for the ever-increasing future demands and besides it is, at present, not fully satisfactory in quality. Hence the importation of such bituminous substances from other countries would be necessary to some degree. Moreover, Japan is ill-equipped with machinery for road construction and it would be of the utmost importance to bring about the importation of suitable machinery, as well.

GOOD FUTURE FOR CONCRETE PAVEMENTS.

At present Japan has no paving-brick factories whatsoever, and it is also a matter of doubt whether or not the future will see this industry established in Japan. The matter has never been given a thorough research, although other brick and clay industries are carrying on flourishing trade in Japan. We have many portland cement factories in Japan which produce good cement for road paving purposes, and even export to foreign countries. Hence the cement concrete pavement has quite a great future before it in Japan.

Solidifying Embankments

The settlement of newly-laid earth embankments for highways is accelerated and a permanent condition reached that prevent a large amount of cracking of the concrete surface by the application of the ponding method. This simply consists of building a clay dam or dyke 12 inches high at both sides of the road with occasional transverse dams of the same height about 10 feet apart and keeping the enclosed area saturated with water penetrating to the bottom through full depth post holes afterwards backfilled. Usually sufficient saturation is secured by filling nearly to the top of the dams two or three times.

A big sewer cleaning job was recently done at Dubuque, Ia., where 3,800 yards of material were taken from 3,100 linear feet of sewers, 9 feet wide and 7 feet high, that were filled to a depth of 4 feet with mud and dirt and rubbish, including 400 loads of macadam that will be used for city road work this spring. The obstructions were so serious that they had caused the sewers to overflow and produced destructive floods in the streets.

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The National Highway Bill

As congressional action becomes more imminent on the Townsend Bill to create a new Federal department to administer the highway affairs of the United States, it may be well to again define some of its principal features for the purpose of reassuring those who may still be in doubt of the beneficial results of such legislation, especially those who are inclined to oppose it on the ground that the Act proposes to take over all highway work as a Federal function, thus interfering with present state highway departments and jeopardizing Federal aid for state improvements.

Quite the reverse is true in that, far from superseding the Federal aid plan, the highway act seeks to extend that plan and assist the different states in their local improvements by relieving them of the construction and maintenance of the routes that may be designated as portions of the National system. The roads so designated will, however, it is estimated, amount to only about 1 per cent of the total mileage in each state, a proportion that certainly could not dominate the rest

The unassailable system of the Act is to provide for the harmonious design, construction and maintenance of Interstate lines so that the different elements will be co-ordinated and secure the greatest efficiency and the shortest and best routes for through traffic, interlocking all portions of the system and making all sections equally available, uniform and continuous.

Such a system has the advantages that it should serve as a model and an incentive for local highway construction, that it will afford superior outlet for the increasing traffic originated on local roads, that it will eliminate a great deal of waste, delay and duplication, and especially that it will rapidly provide almost unlimited facilities for motor trucking that, in the not impossible contingency of railroad strikes, will insure a degree of flexible and independent transportation by motor trucks with private, corporate and municipal operation would greatly relieve the paralysis of commerce, congestion of freight, and scarcity of food that would be otherwise inevitable.

Another most important consideration, and one that could hardly be provided for by independent state action, is the planning of Federal roads so as to give a network of communication between military points that would be invaluable in case of invasion, industrial trouble or any other disorders that require mobilization of men, or supplies, or ordnance. It was the possession of such a system of well located, designed and constructed roads that gave Germany an opportunity to commence a war with an impetus that carried beyond the zone of her own road systems, and required such a vast expenditure of life and treasure to subdue. Such systems on our long unfortified sea coast and on our Mexican border are obviously necessary and would vastly reduce the cost and delay and correspondingly increase the efficiency of any adequate system of defense.

Municipal Sand and Gravel Plants

There are very few cities, towns, or villages but that require large quantities of sand and gravel for concrete for public works and all of them, as well as counties, require it for road building. In very many cases it is purchased at a disadvantage often with uncertain delivery and at high prices when it might as well, or better, be provided by the municipality.

There are two principal sources, one or the other of which is almost always available, namely, excavations for the work under construction or at nearby points that may provide either sand or gravel or both with or without washing and screening; and the opening of banks or pits for a permanent supply. The latter is likely to involve longer hauls but has the advantage of usually affording a larger and better supply.

In either case, materials can be excavated, stored and delivered with a simple equipment and common labor at a cost which there is no good reason should be greater than that of the ordinary producer or dealer, thus securing independence and economy. The establishment of such a plant or plants involves only a very moderate investment of standard equipment, which can easily be bought and sold in open market and will afford employment for a regular crew that should pay dividends on their cost, as well as giving an opportunity for employment of regular forces when they cannot be used for their usual work, thus keeping up the organization and benefitting the men.

Sand and gravel production can be carried on throughout the winter when most forms of construction are impeded and supplies can be provided in advance for hurried work.

A source of supply that often yields the best quality of material is frequently overlooked in the deposits in the beds of creeks, rivers and ponds, the location of which has the additional advantage of insuring abundance of water for washing and for facilitating handling. Some hints of a simple method of operations may be found from the article on page 290, and any competent engineer or superintendent can modify the system there described or perhaps can see advantages in an entirely different system such, for instance, as dredging material with pumps where a large output is required.

Politics Eliminated from Road Building

A principle that is vital to all public construction was emphasized recently by Wm. C. Sproul, governor of Pennsylvania, who, in an address to 300 engineers, assistant engineers and inspectors of the State Highway Department in annual convention at Harrisburg, assured them that the "intervention of politics will not hurt any state highway department employe who tries to do his duty."

The Governor defined the state highway department as a non-political organization which is planned to be a very large and businesslike department especially intended to serve as a model for other state departments in Pennsylvania and throughout the country, and assured his hearers that loyalty and efficiency on their part would insure promotion.

Such a policy extended through the 800 miles of new construction planned for Pennsylvania during 1920 is worthy of the progressive spirit that has undertaken the improvement and, if well observed, cannot fail to bring immediate reward in the excellence and economy of the work, besides which it will strengthen the foundations for better working conditions that are so much needed throughout the country, especially at this time when we are recovering from the war emergency and the relaxation and temporary arrangements necessitated, or believed to be justified by the emergency.

There is no sufficient reason why public works should not be carried on with the efficiency, rapidity and economy that are attained by private enterprises if only all considerations were governed by intrinsic merit, efficiency, honesty, and economy, which would enable the great public resources to secure even better results than can be obtained by limited private enterprise. If there is no political pressure allowed to interfere with the reward of efficiency or the removal of inefficiency, and if the zeal of making the work profitable can be made as great as is commanded by self-interest in private enterprises and the public be no longer looked upon as a boundless reservoir from which to draw unlimited amounts to cover mistakes, graft, and extravagance, road building and other kinds of public work will rise to great success and in the end even the political reward will be greater than ever because such results from any administration will be its highest testimonial and one of great worth with the people.

County Highway Data

Responding to requests of PUBLIC WORKS, county engineers and other county officials representing between three hundred and four hundred counties of the various states have furnished, during the past month, answers to a questionnaire, which we have tabulated and present in this issue. Other tabulations will be presented in later issues.

Hundreds of millions were spent on road work last year, in spite of the various adverse conditions and delay in getting started after the war. Part of this was spent by states, part by counties, by townships or other units. In most of the states a large part of the expenditure was made by the counties, although in a few the counties as such do no road work, as in Vermont. In almost every state, however, federal, state, county and township funds were combined in different proportions in carrying out the road program.

To learn how much was spent in a number of typical counties last year, and in what way, we have secured, through the courtesy of county officials, a considerable amount of data concerning about four hundred counties scattered throughout the several states. Most of these have been tabulated and are given in following pages. Others, which we have had neither time for tabulation nor space for publishing in this issue, will be published in later issues.

The data given in the first table were furnished in reply to the following questions:

"How much money, including county, state and federal appropriations, was spent during 1919 for highway work in your county?"

"What kinds of road surface were constructed, and what amount of each?"

"How much of the above was done by county or state forces?"

"How much was done by contract."

The second table contains the answers to the following questions:

"What width of shoulders do you use with each type of road?"

"What surface material is laid on or other treatment given to the shoulders?"

"How do you protect (by curb or otherwise) the outer edge of your pavements?"

The third table contains information derived from replies to the questions:

"What kinds of pavement did you resurface last year?"

"What kinds of material were used for resurfacing each of these?"

"How long had the old pavements on the several roads been in service?"

"What was done to the old surface before adding the new material?"

"What was the cost of each class of resurfacing, per square yard or mile?"

"In what way, if any, did you use the materials removed from the old pavements?"

Data were obtained concerning maintenance of several kinds of road surface, but only water-bound macadam is given this week; the others will appear in later issues. Informants were requested to state whether the costs given included anything besides labor and material; also to state approximately the average number of vehicles per day, their average weight, etc.

COUNTY HIGHWAY WORK DONE DURING 1919.

State and County	Amount of county, state and federal money spent.	Bituminous concr. miles or sq. yds.	Bituminous macadam miles or sq. yds.	Plain macadam miles or sq. yds.	Sand-clay miles or sq. yds.	Gravel miles or sq. yds.	Cement concrete miles or sq. yds.	Brick miles or sq. yds.	Earth miles or sq. yds.	Other work.	Done by county or state forces.	Done by contract.
Alabama:												
Calhoun	$9,900		12							Chert, 15	None	All
Etowah	55,000		4½						10		75 per cent.	25 per cent.
Monroe	12,000					4½					All	None
Arkansas:												
Jefferson	300,000		20			15					10 per cent.	90 per cent.
Miller	150,000					69					None	All
Scott	20,000									Grading only	All	None
Sevier	400,000					60—8"x14'					None	All
Several (not named)	100,000					14½					None	All
California:												
Plumas	55,000								All		All	None
Solano	200,000						3			Repairs & bridges		
Connecticut:												
Fairfield	20,000			0.75							All	None
Delaware:												
Sussex										All by state	None	All
Florida:												
Bay	300,000				15				100		None	All
Brevard	120,000									Shell	All	None
Dade	175,000			25						Coral rock, 25	All	None
Hillsborough	350,000									Asphalt block on shell base, 10; shell, 15	Shell	Asphalt block
Levy	100,000				20					Coral rock, 10	20	10
Pasco	50,000			6							None	All
Sumter	14,000				Some					Maintenance	All	None
Idaho:												
Bonneville	3,500									Surveys		
Jerome	75,000									Grading & culverts, 15	All	None
Payette	10,000					3					All	None
Illinois:												
Carroll	64,000			4		3	0.5			Grading, 20; oiling, 8	None	All
Christian	170,000								9	Oiling, 64	9	21
Dewitt	100,000								40		35	5
Douglas	153,000			2.5			2.1	3.5			None	All
Fulton	180,000						2.5			Oiling, 15	Oiling	Concrete
Hamilton	30,000								300		$27,000	$3,000
Iroquois	650,000						20				Very little	Almost all
Kane	420,000						2				None	All
Knox	120,000								All	Some oiled	All	None
Lake	175,000						5.5				None	All
Lawrence	90,000					18					None	All
Logan	98,974					20					None	All
McDonough	100,000									Oiling, 70	All	None
Macoupin	65,000						2.5				None	All
Madison	350,000		Repair 2.5				6.5	3.6			2	10,6
Monroe	39,000									Grading, 500	All	None
Ogle	285,000						6.5		Some		None	All
Pike	36,000					7					All	None
Schuyler	100,000						1.5		Some		Earth	Concrete
Wabash	20,000					6					None	All
Warren	44,000					1	0.75				None	All
Indiana:												
Adams	74,444		Repair 15								None	All
Delaware	28,690			2		2					Maintenance	New construction
DeKalb	68,500	2.5		2		4	2				None	All
Franklin	50,000			3		4					None	All
Fulton	98,000					12			2		None	All
Hancock	200,000			10		25	3.5				None	All
Howard	110,000	1.5		2		4	2				None	All
Jennings	28,000			2.4							None	All
Posey	50,000					6					None	All
Shelby						11.5	1.5				None	All
Tippecanoe	240,200					20		6			None	All
Vigo						10,000	24,000	30,500		Asphalt, $72,000	None	All

COUNTY HIGHWAY WORK DONE DURING 1919 (Continued).

State and County	Amount of county, state and federal money spent.	Bituminous concr. miles or sq. yds.	Bituminous macadam miles or sq. yds.	Plain macadam miles or sq. yds.	Sand-clay miles or sq. yds.	Gravel miles or sq. yds.	Cement concrete miles or sq. yds.	Brick miles or sq. yds.	Earth miles or sq. yds.	Other work.	Done by county or state forces.	Done by contract.
Iowa												
Bremer	103,000	.....	.....	.....	.....	2	.....	.....	6	.....	All	Bridges
Buena Vista	88,237	.....	.....	.....	.....	39	.....	.....	.....	.....	None	All
Cerro Gordo	153,000	.....	.....	.....	.....	.....	2	.....	.....	.....	None	All
Clarke	60,000	.....	.....	.....	.....	.....	.....	.....	Maint.	.....	All	None
Clay	33,194	.....	.....	.....	.....	10	.....	.....	.....	.....	4	6
Clinton	166,155	.....	.....	.....	.....	1	.....	.....	.....	Grading, 14	None	All
Davis	72,000	.....	.....	.....	.....	.....	.....	.....	.....	Grading, $20,500; bridges, $51,500	All	None
Decatur	39,500	.....	.....	.....	.....	.....	.....	.....	165	.....	All	None
Dickinson	20,000	.....	.....	.....	.....	maintenance	.....	.....	.....	.....	All	None
Emmet	105,665	.....	.....	.....	.....	38.5	.....	.....	15	.....	None	All
Fayette	120,000	.....	.....	.....	.....	.....	.....	.....	10	.....	All	None
Greene	111,173	.....	.....	.....	.....	4.82	.....	.....	.....	.....	2	2.82
Grundy	40,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	$15,000
Hamilton	197,000	.....	.....	.....	.....	34	.....	.....	.....	Bridges, $78,000	None	All
Harrison	38,500	.....	.....	.....	.....	.....	.....	.....	21.5	.....	All	None
Humboldt	88,500	.....	.....	0.5	.....	12	.....	.....	.....	.....	Macadam	Gravel
Ida	135,646	.....	.....	.....	.....	.....	.....	.....	Maintenance	Bridges & culverts, $97,582	All roads	Bridge, $18,500
Iowa	195,839	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Jasper	77,000	.....	.....	.....	.....	$7,000	.....	.....	.....	.....	.....	$20,000
Johnson	150,000	.....	.....	.....	.....	.....	.....	.....	All	.....	All	None
Keokuk	30,741	.....	.....	.....	.....	.....	.....	.....	.....	Grading & draining	None	All
Kossuth	67,000	.....	.....	.....	.....	2.5	.....	.....	22	.....	None	All
Lucas	115,056	.....	.....	.....	.....	.....	.....	.....	All	.....	$97,055	$18,000
Lyon	80,000	.....	.....	.....	.....	8	.....	.....	.....	.....	$43,000	$37,000
Mills	110,000	.....	.....	.....	.....	.....	.....	.....	.....	Grading	$70,000	$40,000
Mitchell	119,500	.....	.....	.....	.....	2	.....	.....	.....	Grading & draining	All	None
Monroe	64,774	.....	.....	.....	.....	.....	.....	.....	.....	Grading, 3	None	All
Montgomery	253,000	.....	.....	.....	.....	.....	.....	.....	All	.....	All	None
Muscatine	79,576	.....	.....	.....	3.06	.....	.....	.....	.....	.....	None	All
O'Brien	100,000	.....	.....	.....	.....	.....	.....	.....	All	.....	None	All
Palo Alto	40,205	.....	.....	.....	.....	.....	.....	.....	.....	Grading, draining, purchasing gravel pits	.....	.....
Plymouth	39,932	.....	.....	.....	.....	.....	.....	.....	.....	Grading, 12	All	None
Ringgold	127,077	.....	.....	.....	.....	.....	.....	.....	$30,304	Bridges & culverts, $96,773	Earth, $26,304	The rest
Sac	86,350	.....	.....	.....	.....	1.25	.....	.....	.....	.....	$70,000	Bridges, $16,350
Scott	.....	.....	.....	2.5	.....	.....	.....	.....	8	.....	None	All
Shelby	28,799	.....	.....	.....	.....	.....	.....	.....	All	.....	All	None
Story	126,000	.....	.....	.....	.....	27	.....	.....	.....	.....	None	All
Union	48,000	.....	.....	.....	.....	.....	.....	.....	All	.....	.....	$15,000
Van Buren	40,000	.....	.....	.....	.....	.....	.....	.....	All	.....	All	None
Kentucky												
Bell	20,000	.....	.....	6	.....	.....	.....	.....	.....	Grading, 2	None	All
Boone	87,600	.....	.....	All	.....	.....	.....	.....	.....	.....	$35,137	$52,475
Henderson	153,300	.....	.....	.....	.....	6	.....	.....	.....	.....	4	2
Owen	50,000	.....	.....	11	.....	.....	.....	.....	.....	.....	9	2
Rockcastle	81,190	.....	.....	2	.....	1	.....	.....	8.5	.....	All but	5.5 earth
Whitley	42,000	.....	.....	.....	.....	.....	.....	.....	.....	Grading, drainage, bridges	$27,000	$15,000
Louisiana												
Avoyelles	30,000	.....	.....	.....	.....	All	.....	.....	.....	.....	None	All
Richland	40,000	.....	.....	.....	.....	9.5*	.....	.....	.....	.....	None	All
Maine												
Penobscot	52,164	.....	.....	.....	.....	6.04	.....	.....	.....	.....	All	None
Michigan												
Alger	138,000	.....	.....	5	.....	.....	.....	.....	6	.....	50%	50%
Cass	200,000	.....	.....	.....	.....	30	7	.....	.....	.....	28	9
Eaton	113,327	.....	.....	.....	.....	15.5	.....	.....	.....	.....	7.5	8
Gogebic	150,000	.....	1.5	.....	.....	.....	.....	.....	.....	Grading, 10	None	All
Luce	56,000	.....	.....	.....	.....	4	.....	.....	.....	.....	All	None
Macomb	1,000,000	25.62	3.50	.....	.....	21.57	3.875	.....	.....	.....	None	All
Marquette	148,000	.....	.....	5	.....	6.5	.....	.....	.....	Grading, 3	Macadam	All other

Mecosta	.....	.....	.....	.....	.....	7	.....	.....	.....	.....	None	All
Muskegon	88,000	.....	.....	.....	.....	.....	.....	.....	.....	Maintenance	All	None
Schoolcraft	125,000	.....	2.5	1.5	.....	1.0	.....	.....	.....	.....	All other	Bit. macadam
Minnesota												
Aitkin	30,000	.....	.....	.....	.....	6	.....	.....	.....	.....	2	4
Big Stone	97,000	.....	.....	.....	.....	5	.....	.....	.....	Grading, 28	None	All
Brown	99,227	.....	.....	.....	.....	21	.....	.....	.....	Grading, 16	Gravel & 5 mi. of grading	All other
Carlton	117,000	.....	.....	.....	.....	5	.....	.....	.....	Grading, 20	3 mi. of gravel	All other
Chippewa	131,837	.....	.....	.....	.....	6	.....	.....	15	Maintenance	Maintenance	$80,720
Chisago	145,000	.....	.....	.....	.....	40†	.....	.....	.....	.....	None	All
Crow Wing	150,000	.....	.....	.....	.....	6.5	.....	.....	.....	Grading, 14	4¼ of gravel	All other
Dakota	.....	38,653	.....	.....	.....	3.0	.....	.....	.....	.....	.....	.....
Dodge	105,000	.....	.....	.....	.....	5	.....	.....	14	.....	2	17
Goodhue	234,556	.....	.....	.....	.....	13	2	.....	25	.....	4 of gravel	All other
Grant	45,000	.....	.....	.....	.....	7	.....	.....	7	.....	None	All
Itasca	150,000	.....	.....	.....	.....	4	.....	.....	9	.....	None	All
Jackson	102,000	.....	.....	.....	.....	.....	.....	.....	.....	Grading & 5 mi. oiling	All	None
Kanabec	40,000	.....	.....	.....	.....	All	.....	.....	.....	.....	All	None
Kandiyohi	205,000	.....	.....	.....	.....	9	1.5	.....	.....	Grading, 15	All but	Concrete
Lyon	200,600	.....	.....	.....	.....	19	.....	.....	.....	Grading, 16	None	All
Marshall	92,140	.....	.....	.....	.....	20	.....	.....	.....	Grading, 38	None	All
Nicollet	49,384	.....	.....	.....	.....	3	.....	.....	.....	Maintenance & equipment	None	All
Sibley	62,000	.....	.....	.....	.....	16	.....	.....	.....	.....	1.75	14.75
Stearns	125,000	.....	.....	.....	.....	12	.....	.....	.....	.....	$65,000	$60,000
Steele	58,604	.....	.....	.....	.....	9.5	.....	.....	9.5	.....	None	All
Stevens	66,815	.....	.....	.....	.....	.....	1.1	.....	.....	.....	None	All
Wadena	20,877	.....	.....	.....	1	.....	.....	.....	.....	Maintenance	All	None§
Waseca	90,000	.....	.....	.....	.....	11	.....	.....	8	.....	All	None
Watonwan	80,000	.....	.....	.....	.....	.....	.....	.....	20	.....	None	All
Missouri												
Callaway	51,000	.....	.....	.....	.....	.....	.....	.....	12	Maintenance, $19,000	All	None
Camden	20,000	.....	.....	.....	.....	.....	.....	.....	75	.....	All	None
Carter	40,000	.....	.....	.....	.....	.....	.....	.....	28	.....	All	None
Clark	13,000	.....	.....	.....	.....	.....	.....	.....	All	.....	All	None
Cooper	75,000	.....	.....	.....	.....	.....	.....	.....	All	.....	None	All
Harrison	.....	.....	.....	.....	.....	.....	.....	.....	All	.....	.....	.....
Jefferson	20,000	.....	.....	Part	.....	Part	.....	.....	.....	.....	All	None
Lincoln	37,753	.....	.....	.....	.....	8	.....	.....	35	.....	All	None
Mississippi	20,000	.....	.....	.....	.....	.....	.....	.....	.....	Grading & maintenance	.....	.....
Monroe	32,000	.....	.....	.....	.....	.....	.....	.....	Maintenance	Grading, culverts, &c.	All	None
Morgan	30,100	.....	.....	.....	.....	Part	.....	.....	Part	.....	All	None
Ozark	20,000	.....	.....	.....	.....	.....	.....	.....	.....	Maintenance	All	None
Pearl River	45,000	.....	.....	.....	.....	.....	.....	.....	All	.....	All	None
Phelps	40,000	.....	.....	.....	.....	10	.....	.....	20	.....	All	None
Polk	20,000	.....	.....	.....	.....	.....	.....	.....	50	.....	All	None
St. Clair	31,248	.....	.....	.....	.....	.....	.....	.....	.....	Grading	.....	.....
Washington	43,000	.....	.....	.....	.....	10	.....	.....	.....	Grading, 30	All	None
Yazoo	.....	.....	.....	.....	.....	All	.....	.....	.....	.....	None	All
Montana												
Beaverhead	61,500	.....	.....	.....	.....	2	.....	.....	50	.....	All	None
Carbon	190,000	.....	.....	.....	.....	6	.....	.....	120	.....	$150,000	$40,000
Cascade	350,000	.....	.....	.....	.....	5	.....	.....	100	Cinder, 6	$212,000	$138,000
Chouteau	118,945	.....	.....	.....	.....	.....	.....	.....	All	.....	$111,000	$8,000
Gallatin	175,680	.....	.....	5	.....	.....	.....	.....	20	.....	$109,634	$66,047
Granite	20,000	.....	.....	.....	.....	1	.....	.....	.....	Maintenance	All	None
Hill	50,000	.....	.....	.....	.....	.....	.....	.....	All	.....	All	None
Madison	71,380	.....	.....	.....	.....	.....	.....	.....	Maintenance	.....	All	None
Musselshell	246,814	.....	.....	.....	.....	.....	.....	.....	All	.....	.....	33%
Sanders	48,000	.....	.....	.....	.....	3	.....	.....	.....	.....	All	None
Stillwater	35,000	.....	.....	.....	.....	.....	.....	.....	.....	Maintenance	All	None
Valley	75,000	.....	.....	.....	.....	1⅛	.....	.....	.....	.....	All	None
Nebraska												
Custer	30,000	.....	.....	.....	40	.....	.....	.....	.....	Clay & straw, 8	All	None
Knox	20,000	.....	.....	.....	.....	.....	.....	.....	.....	Grading, 60	All	None
Platte	105,734	.....	.....	.....	.....	.....	.....	.....	$65,734	Bridges, $40,000	$30,000	All other
Saline	30,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wayne	75,000	.....	.....	.....	.....	.....	.....	.....	All	.....	50%	50%
New Jersey												
Burlington	775,000	.....	.....	.....	.....	.....	$75,000	.....	.....	Sheet asphalt, $400,000; maintenance, $300,000	$150,000	$625,000
Hunterdon	130,000	.....	1	.....	.....	.....	.....	.....	.....	Maintenance	All	None
Mercer	.....	.....	.....	4,267	.....	44,631	.....	3,300	.....	Sheet asphalt, $17,000	None	All
Marquette	148,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

COUNTY HIGHWAY WORK DONE DURING 1919 (Continued).

State and County	Amount of county, state and federal money spent.	Bituminous concr. miles or sq. yds.	Bituminous macadam miles or sq. yds.	Plain macadam miles or sq. yds.	Sand-clay miles or sq. yds.	Gravel miles or sq. yds.	Cement concrete miles or sq. yds.	Brick miles or sq. yds.	Earth miles or sq. yds.	Other work.	Done by county or state forces.	Done by contract.
Passaic	595,813	3.1	.....	2.25	.....	.....	3.2	.....	.....	Sheet asphalt, 0.65; repairing 155 mi.	Repairing & Oiling	All other
Somerset	140,817	.....	.....	6	.....	.....	.....	.....	.....	Various kinds	All other	All macadam
Union	.....	24,663	.....	.....	.....	.....	19,212	.....	.....	.....	.....	.....
New York											All	None
Chenango	79,000	.....	3.75	3.45	.....	5	.....	.....	.....	.....	None	All
Cattaraugus	256,425	.....	.....	.....	.....	.....	.....	.....	.....	.....	None	All
Chautauqua	73,174	.....	.....	.....	.....	.....	.....	.....	.....	.....	None	All
Erie	206,555	.....	.....	.....	.....	.....	.....	.....	.....	.....	$59,100	$81,073
Lewis	140,173	.....	All	.....	.....	.....	.....	.....	.....	.....	None	All
Niagara	86,399	.....	.....	.....	.....	.....	.....	.....	.....	.....	None	All
Otsego	95,000	.....	.....	.....	.....	.....	1.35	.....	.....	Repairs, $44,339	$44,339	$81,021
Schenectady	125,360	.....	.....	11.95	.....	.....	1.92	.....	.....	.....	Maintenance	Construction
North Carolina										.....	All	None
Person	80,000	.....	.....	.....	.....	.....	.....	.....	10	.....	All	None
Union	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Washington	15,000	.....	.....	.....	Maint.	.....	.....	.....	.....	.....	.....	.....
North Dakota										.....	.....	.....
Williams	100,000	.....	.....	.....	.....	.....	.....	.....	76	.....	Macadam	Brick
Ohio										Cinder, 5	Cinder	Macadam
Ashland	.....	.....	.....	4.5	.....	.....	.....	10	.....	.....	.....	5 miles
Carroll	50,000	.....	.....	3	.....	.....	.....	.....	.....	Maintenance & repairs	$56,000	$249,205
Champaign	100,000	.....	.....	Part	.....	Part	.....	.....	.....	.....	Macadam	All other
Clark	305,205	.....	9.4	.....	.....	.....	.....	.....	.....	.....	.....	All
Coshocton	198,339	.....	.....	2.6 resurface	.....	.....	25	26	.....	.....	50%	50%
Darke	620,000	.....	.....	.....	.....	$175,463	$274,193	$170,344	.....	.....	.....	.....
Erie	200,000	.....	.....	10	.....	.....	4	.....	.....	State road, 8	8	28
Fairfield	125,000	.....	.....	5	.....	.....	1⅛	.....	.....	.....	None	All
Fulton	340,000	.....	.....	22	.....	6	.....	.....	.....	.....	None	All
Hancock	120,768	All	.....	.....	.....	.....	.....	.....	.....	.....	Macadam, 2	All other
Henry	228,034	.....	.....	16	.....	2	.....	.....	.....	Grading, 3.59	None	All
Highland	600,000	.....	8	20	.....	6	.....	.....	.....	.....	None	All
Holmes	110,847	.....	.....	.....	.....	4.85	0.16	.....	.....	.....	50%	50%
Huron	268,000	.....	.....	2.25	.....	.....	5.4	7.68	.....	.....	.....	.....
Jefferson	140,000	.....	.....	Maint.	.....	.....	.....	2	.....	Loose stone, 2; maintenance, $60,000	Maintenance	Construction
Logan	140,000	.....	.....	.....	.....	Part	Part	.....	.....	.....	.....	.....
Madison	281,731	.....	8.39	2.27	.....	.....	.....	.....	.....	.....	None	All
Muskingum	46,120	.....	0.45	.....	.....	.....	0.6	.....	.....	.....	.....	.....
Ottawa	300,000	.....	.....	.....	.....	.....	$100,935	.....	.....	Maintenance	Maintenance	Construction
Preble	145,227	.....	2.25	.....	.....	.....	.....	.....	.....	Loose stone, 7	2.35	9.65
Putnam	269,000	.....	2	3	.....	.....	.....	.....	.....	By state, 3.5	None	All
Richland	562,970	.....	5.75	3	.....	15	4.25	0.25	.....	.....	None	All
Sandusky	400,000	.....	.....	9	.....	.....	.....	5.74	.....	.....	None	All
Shelby	80,000	.....	1.75	.....	.....	.....	3.5	.....	.....	.....	None	All
Stark	.....	.....	6.4	1.3	.....	.....	.....	1.6	.....	Stone block, 1.800	None	All
Summit	236,814	75,570	.....	.....	.....	.....	.....	2,208	.....	.....	None	All
Tuscarawas	75,000	.....	.....	.....	.....	.....	2.34	.....	.....	.....	None	All
Williams	350,000	2	12	11	.....	.....	6	.....	.....	.....	.....	.....
Oklahoma									All	.....	Grading	Culverts
Choctaw	50,000	.....	.....	.....	.....	.....	.....	.....	All	.....	50%	50%
Craig	40,000	.....	.....	.....	.....	.....	.....	.....	All	Bridges	Over half	
Kingfisher	121,411	.....	.....	.....	.....	.....	.....	.....	.....	Sheet asphalt, 2.5	None	All
Muskogee	137,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	$166,000	$405,000
Pottawatomie	571,000	.....	.....	.....	All	.....	.....	.....	.....	Clay-stone, 3	Clay-stone	Sand-clay
South Carolina										.....	$150,000	$50,000
Cherokee	175,000	.....	.....	.....	25	.....	.....	.....	.....	Maintenance, $55,000	Maintenance	Construction
Chester	200,000	.....	.....	.....	All	.....	.....	.....	.....	.....	.....	.....
Greenwood	115,000	.....	.....	.....	10	.....	.....	.....	.....	Bridges, $54,000	All	None
Lancaster	53,000	.....	.....	.....	.....	.....	.....	.....	15	Bridges, $39,493; maintenance, $4,258.	$14,511	All other
South Dakota												
Beadle	101,668	.....	.....	.....	.....	.....	.....	.....	$12,595			
Clay	56,347	.....	.....	.....	.....	.....	.....	.....				

Codington	50,030	.....	.....	.....	.....	8	.....	.....	28
Custer	.....	.....	.....	.....	.....	.....	.....	.....	24

Codington	50,030	.....	.....	.....	.....	8	.....	.....	28	.....	24	12
Custer	25,000	.....	.....	.....	.....	.....	.....	.....	43	.....	All	None
Davison	43,000	.....	.....	.....	.....	.....	.....	.....	All	.....	All	None
Gregory	65,000	.....	.....	.....	.....	.....	.....	.....	50	.....	$60,000	$5,000
Haakon	8,000	.....	.....	.....	.....	.....	.....	.....	29	.....	All	None
Jackson	13,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	All	None
Meade	22,000	.....	.....	.....	.....	.....	.....	.....	42	Hard surface, 83	42	3
Miner	9,000	.....	.....	.....	.....	.....	.....	.....	.....	Clay	All	None
Spink	45,000	.....	.....	.....	.....	.....	.....	.....	100	.....	83	17
Tripp	60,000	.....	.....	.....	.....	.....	.....	.....	70	.....	All	None
Walworth	40,000	.....	.....	.....	.....	.....	.....	.....	60	.....	All	None
Tennessee												
Cocke	30,000	.....	.....	3	.....	1	.....	.....	.....	Grading, 16	All	None
Giles	128,060‡	.....	.....	15	.....	70	.....	.....	.....	Grading	.....	.....
Greene	101,585	.....	.....	14	.....	.....	.....	.....	38	.....	None	All
Hamilton	100,000	.....	.....	$20,000	.....	.....	.....	.....	.....	Oiling, $20,000; chert, $10,000; maint., $50,000	$80,000	$20,000
Hawkins	25,000	.....	.....	.....	.....	.....	.....	.....	.....	Grading, 150	Most	.....
Lewis	50,000	.....	.....	.....	.....	.....	.....	.....	18	Repairs, $7	12	13
Roane	85,000	.....	.....	.....	.....	.....	.....	.....	.....	Grading	All	None
Wilson	30,000	.....	.....	5 rebuilt	.....	.....	.....	.....	.....	Repairs	All	None
Utah												
Carbon, Duchesne, Emery, Grand, San Juan & Uinta	100,000	.....	.....	.....	.....	.....	.....	.....	69	.....	Half	Half
Vermont												
Bennington	23,262	.....	.....	.....	22,084	.....	.....	.....	.....	.....	All	None
Virginia												
Augusta	100,000	.....	.....	4.5	.....	6	.....	.....	.....	.....	.....	.....
Campbell	100,000	.....	3	.....	.....	.....	.....	.....	.....	.....	All	None
Fairfax	60,000	.....	4.5	.....	.....	4	.....	.....	.....	"Grey soil," 5	None	All
Halifax	140,000	.....	.....	.....	.....	.....	2	.....	.....	.....	Bit. mac.	Gravel
Henrico	40,000	.....	1.25	.....	.....	5	.....	.....	.....	"Grey soil," 20	Soil	Concrete
Pittsylvania	145,000	.....	4.5 resurf.	18	.....	.....	.....	.....	20	.....	Gravel	Bit. Mac.
Scott	125,000	.....	.....	5	.....	.....	.....	.....	.....	.....	Macadam	.....
Wise	90,000	.....	Part	Part	.....	.....	.....	.....	.....	Grading, 15	15	5
Washington										.....	$70,000	$20,000
Clallam	150,000	.....	.....	.....	.....	All	.....	.....	.....	.....	.....	.....
Kittitas	64,800	.....	.....	.....	.....	2	.....	.....	.....	.....	2/3	1/3
Lincoln	.....	.....	.....	.....	.....	.....	.....	.....	.....	Grading, 2.4; Maintenance, $45,400	Maintenance	Construction
Okanogan	309,000	.....	.....	.....	.....	29	.....	.....	.....	.....	.....	.....
Pend Oreille	37,912	.....	.....	.....	.....	3.64	.....	.....	.....	.....	.....	23
Pierce	.....	.....	.....	.....	.....	1.41	.....	.....	Some	.....	None	All
Spokane	.....	12,433	.....	68,700	.....	.....	.....	.....	.....	.....	$31,132	$6,780
West Virginia						23,500	92,500	.....	.....	1, kind not stated	.....	.....
Brooke	300,000	.....	.....	2	.....	.....	.....	6	.....	.....	.....	.....
Hancock	64,000	.....	.....	.....	.....	.....	2	1.04	.....	Grading & maint., 180	.....	Brick
Harrison	250,000	.....	.....	.....	.....	.....	3	3	.....	.....	None	All
Jackson	50,000	.....	.....	.....	.....	.....	2.75	.....	.....	.....	None	All
Kanawha	500,000	.....	5	.....	.....	.....	2	3	.....	.....	None	All
Mercer	30,000	.....	0.75 reconstruction	.....	.....	.....	.....	.....	.....	Grading, 1	All	None
Mineral	79,000	.....	3.5	.....	.....	.....	0.25	.....	.....	Grading, 4	Bit. mac.	Grading
Monroe	39,000	.....	.....	1.5	.....	.....	.....	.....	.....	.....	Macadam	All other
Morgan	50,000	.....	.....	.....	.....	.....	0.3	.....	Maintenance	3 bridges	All	None
Nicholas	90,000	.....	.....	.....	.....	.....	.....	.....	9	Maintenance, $15,000	Maintenance	All other
Pleasants	10,000	.....	.....	.....	.....	.....	.....	.....	.....	Grading, 5	All	None
Preston	100,000	.....	2.5	.....	.....	.....	2	.....	.....	Clay-stone, 3	All	None
Putnam	56,000	.....	.....	.....	.....	.....	3	.....	.....	Grading	Bit. mac.	All other
Randolph	100,000	.....	$35,000	.....	.....	.....	.....	.....	.....	Grading, $50,000	1 grading	All other
Ritchie	65,000	.....	.....	.....	.....	.....	0.5	.....	Maint.-$15,000	Grading, 5	Most	.....
Summers	40,100	.....	.....	.....	.....	.....	.....	.....	.....	Drainage	Grading	Concrete
Taylor	35,000	.....	.....	.....	.....	.....	.....	.....	Part	.....	None	All
Wetzel	215,000	.....	.....	.....	.....	.....	0.6	1.5	.....	Grading, 2	All	None
Wisconsin												
Adams	40,000	.....	.....	.....	8	.....	.....	.....	.....	.....	.....	None
Brown	250,000	.....	.....	.....	.....	25	7	.....	.....	.....	All	Concrete
Door	75,000	.....	.....	Part	.....	Part	.....	.....	.....	.....	Gravel	12
Grant	83,825	.....	.....	.....	.....	4.5	.....	.....	.....	.....	14	$26,000
Juneau	34,397	.....	.....	.....	All	.....	.....	.....	.....	Grading, 9.5	$57,825	None
Milwaukee	470,500	1.1	.....	.....	.....	.....	16.75	.....	.....	.....	All	None
Polk	82,000	.....	.....	.....	.....	.....	.....	.....	All	.....	None	All
Richland	150,000	.....	.....	.....	.....	.....	2.75	.....	.....	.....	All	None
Rock	295,657	.....	.....	.....	.....	14	7.33	.....	.....	.....	0.75	2
Trempealeau	275,000	.....	.....	2	.....	12	.....	.....	.....	.....	None	All
Walworth	136,000	.....	.....	.....	.....	10	5.5	.....	.....	Grading, 17	Little	Most
										.....	Gravel	Concrete

*Sand-clay gravel, metal surfacing. †To be given a trap rock surface in 1920. §Three contracts let, but none completed. ‡Includes $100,000 for taxes worked out.

PRACTICE AS TO ROAD SHOULDERS.

State & County	Type of Road	Width of shoulder, ft.	Material used on, or other treatment of shoulder.	Protection of edges of pavement.
Alabama:				
Calhoun	.....	4	None	Concrete curb for brick road
Etowah	.....	3-6	Gravel or chert	None
Monroe	22 ft. gravel	5	Sod, Bermuda grass	.....
Arkansas:				
Sevier	.....	..	None	None
California:				
Fresno	All types	7	Oiled earth	None
Solano	Concrete	Narrow	Broken stone, oiled	None
Sutter	.....	4.5	Old road material	Timber headers
Connecticut:				
Fairfield	.....	5	Rolled spring and fall	Curb when possible
Delaware:				
Sussex	.....	6 to 8	.....	.....
Florida:				
Bay	.....	3	Sod, Bermuda grass	None
Dade	Macadam	Feather edge	.....	None needed
Hillsborough	Brick	6	Shell	Granite or concrete curb
Levy	20 ft. brick	9	Rock	.....
Idaho:				
Jerome	16 ft. gravel	4	Dirt	None
Illinois:				
Carroll	All, 12 ft.	6	None	None
Douglas	Macadam, brick and concrete	One side 4 ft. other side 12	Earth only	Needs none
Fulton	16 ft. brick 16 ft. concr.	3 5	Dragging	Stone or monolithic curb
Iroquois	10 to 15 ft.	7.5 to 10	Earth graded and dragged	None
Kane	18 ft. concrete	6	Earth	None
Lake	18 ft. concrete	6	Earth or old road material	None
Lawrence	9 to 15 ft.	7.5 to 10	Crushed stone for concr. or brk., none for macadam or gravel	None
Macoupin	16 ft. concrete	4	Gravel	None
Madison	10 ft. concrete	3	Macadam	None
Monroe	.....	6	Graded earth	None
Pike	.....	4	None	None
Schuyler	.....	9 to 10	Earth	None
Wabash	.....	6 to 8	Dragging and oiling	None
Warren	.....	8.5	2.5 ft. gravel, 6 ft. earth	Curb for concrete or brick
Indiana:				
Adams	Macadam	4 to 6	None	None
Delaware	.....	3	None	Curb for bituminous
De Kalb	16 to 18 ft.	4	Rolled thoroughly	None
Franklin	12 ft. grv. & mac.	4	.....	None
Fulton	12 ft. gravel 14 ft. mac.	5 4	Rolled Rolled	Curb for concrete or brick .....
Hancock	15 ft. c. or m. 15 ft. gravel	3 2.5	None None	....
Henry	16 ft. gravel	2	None	None
Howard	.....	4 to 5	Rolling	Curb
Jennings	10 ft. gr. or mac.	5	.....	.....
Orange	9 ft. gr. or mac.	3	.....	.....
Posey	10 ft. gr. or mac.	7	None	No hard surface roads
Tippecanoe	Brick or gravel	4	None	None
Vermillion	.....	4	Earth	Concrete curb for brick
Vigo	.....	3 to 5	Earth, gravel or bit. macadam	Curbs for asphalt; concrete headers 3 ft. wide at crossings
Iowa:				
Cerro Gordo	18 ft. concrete	3 to 4	.....	None
Humboldt	.....	4	.....	.....
Ida	26 ft. earth	6	.....	No pavements
Johnson	.....	..	Sodded earth	Curb for brick
Keokuk	18 ft. earth	4	.....	None
Muscatine	16 ft. concrete	4	.....	None
Sac	Gravel	..	Earth	.....
Kentucky:				
Bell	12 ft. macadam	3	Earth	.....
Boone	.....	2 to 3	Rolled	.....
Owen	.....	3 to 5	None	None
Rockcastle	9 ft. macadam 9 ft. gravel	5.5 3	None None	None None
Whitley	14 ft. macadam	3	Clay well rolled	Concrete curb
Louisiana:				
Avoyelles	14 ft. gravel	5	None	None
Richland	14 ft. gravel	5	None	None
Michigan:				
Cass	Gravel Concrete	7.5 4.5	None	None .....
Eaton	.....	5.5 to 7.5	Clay or clay loam	.....
Gogebic	16 ft. macadam	4	.....	.....
Luce	16 ft. macadam	4	Sodded	.....
Macomb	.....	4 or more	Stone or gravel	Curb
Marquette	.....	3.4 to 4.5	Sodded or gravelled	.....
Mecosta	12 ft. gravel	5	None	.....
Muskegon	.....	..	Sodded	None
Schoolcraft	.....	4	None	.....
Minnesota:				
Big Stone	20 ft. gravel	3	.....	.....
Carlton	20 ft. gravel	2	.....	.....
Chisago	20 ft. gravel Pavements	3 6	.....	.....
Crow Wing	18 ft. gravel Concrete	3 6	None	None .....
Itasca	.....	6	Screened gravel	Longit'l rod 6-in. fr. edge pave.
Jackson	Concrete	..	Gravel	.....
Kanabec	.....	2 to 4	Gravel	.....
Kandiyohi	18 ft. concrete	6	Gravel	None
Waseca	20 ft. gravel 18 ft. gravel	2 6	.....	.....
Watonwan	24 ft. gravel	3	.....	.....
Mississippi:				
Jefferson	12 ft. gravel	4	Dirt	.....

PRACTICE AS TO ROAD SHOULDERS (Continued).

State & County	Type of Road	Width of shoulder, ft.	Material used on, or other treatment of shoulder.	Protection of edges of pavement.
Missouri:				
Callaway	9 ft. grav. or mac.	7.5	Earth	.....
Harrison	10 ft. concrete	3	Bituminous	.....
Jefferson	9 ft. g., 9 ft. grav. or mac., 10 ft. m.	3	None	None
Lincoln	16 ft. concrete	3	.....	.....
Mississippi	9 ft. concrete	4	Earth	.....
		3.5 ft. gravel	and 4 ft. earth	.....
Phelps	16 ft. gravel	4	None	.....
Washington	9 ft. gravel.	3	Earth	.....
Montana:				
Madison	16 ft. gravel	None	.....	.....
New Jersey:				
Burlington	18 ft. asph. & con.	6	None	Curb and paving guard
Hunterdon	16 ft. macadam	7	Earth	.....
Mercer	18 ft. con. & mac.	3	Tar or oil dressing	Steel paving guard
Passaic	20-30 ft. conc. & bit. conc.	2 to 5	Tar or asphalt dressing or penetration macadam	.....
Somerset	13 ft. macadam	8	Rolled earth	.....
New York:				
Chenango	12 ft. macadam	5 or 6	Earth	.....
Lewis	.....	No standard	3 or 4 in. loose stone steep grades	One ft. No. 1 stone mixed with K. P., sloping down to shoulder
Otsego	16 ft. various	5	Gravel if soil is clay or silt	Concrete curb for bit. concrete
Schenectady	14-20 ft. various	7	6 in. broken stone 2 ft. wide	.....
North Dakota:				
Barnes	20 ft. gravel	4	Earth	.....
Williams	Earth	4	.....	.....
Ohio:				
Ashland	10 to 16 ft various	4	Rolling	.....
Carroll	16 ft brick & mac.	5	None	Curbs for brick
Champaign	Conc. & bit. conc.	7	Graveled	.....
Clark	12 to 16 ft various	5, 6 and 8	Dressed with 3 to 4 in. gr. ea. yr.	None
Coshocton	16 ft. various	5	None	Concrete breakers for macadam
Darke	Conc., bk., gravel	5	None	None
Erie	.....	At least 5	.....	.....
Fairfield	State roads	5	Gravel	.....
	County roads	3 to 5	None	.....
Fulton	Mac. & bit. mac	5	Gravel for bit. macadam	.....
Hancock	10 to 16 ft various	5	None	Curb
Henry	Various	5	Broken stone	.....
Highland	.....	..	Earth, dragged	.....
Holmes	10 to 14 ft.	6 to 8	Gravel	Curb
Huron	10 ft. concrete	4 to 13	.....	.....
	16 ft. concrete	7	.....	.....
Jefferson	.....	4	.....	Curb for brick
Logan	.....	3 to 5	Earth	.....
Madison	Macadam	7	.....	.....
	Concrete	6	Earth, dragged each year	.....
Muskingum	14 to 16 ft various	5	Loose limestone	.....
Preble	16 ft. various	5	Earth, smoothed with grader	.....
Putnam	Macadam & conc. brick	..	Earth	.....
		..	Concrete	.....
Richland	.....	5 and 6	Rolled	.....
Sandusky	.....	5 or more	.....	Curb
Shelby	.....	5	Earth	None
Stark	.....	5 to 8	None	Conc. curb or 18-in. bit. shoulder
Summit	.....	4 ft. one side.	12 ft. dirt road on the other	Gravel or slag shoulder
Tuscarawas	All types	5	Gravel	Curb
Williams	All types	5	Earth, sometimes scraped	4-in. conc. curb for bit. concr.
Oklahoma:				
Muskogee	.....	3	Dirt	.....
Pottawatomie	Sand-clay	4	None	.....
South Carolina:				
Cherokee	.....	4 to 6	Earth	.....
Greenwood	Concrete	10	Top soil	.....
Tennessee:				
Cocke	Macadam	6 and 8	None	.....
Greene	.....	3 and 4	.....	.....
Hamilton	.....	4	With conc., chert with asph. oil	None
Lewis	.....	6	.....	.....
Utah:				
Fifth District	.....	4	Earth	None
Virginia:				
Campbell	Macadam	3	Sometimes 2 ft. of crushed stone	Conc. curb when conc. base.
Fairfax	Macadam	3	Earth	.....
Halifax	Concrete	3	None	None
Henrico	All types	3	Rolled and scraped regularly	None
Pittsylvania	.....	3	Earth	.....
Scott	.....	4	Earth	.....
Wise	.....	3	.....	None
Washington:				
Kittitas	.....	4	Rolled	Wood curb for Warrenite on concrete, concrete curb for brick
Pierce	.....	4	None	3x6-in. wood curb
Brooke	.....	2	Earth	Concrete curb for brick
West Virginia:				
Hancock	.....	4 & 4 or 2 & 9	Smoothed and rolled	.....
Harrison	.....	3 to 5	None	Curb
Kanawha	Conc. & asp. conc.	4	w. b. macadam	.....
Mercer	.....	3	None	.....
Mineral	.....	3	Broken stone and tarvia, tamped	.....
Monroe	.....	5	.....	.....
Morgan	Concrete	5	Shale and dirt	None
Pleasants	Earth	4	None	.....
	Concrete	3	.....	.....
Preston	.....	3 to 4	.....	.....
Putnam	9 ft. concrete	2.5	Stone, rolled	.....
Randolph	.....	3	Earth	.....
Ritchie	Concrete	5	Earth	None; corners trowled
Summers	.....	3.5	.....	Flat curb
Taylor	Brick	3.5 and 4.5	.....	Curb
Wetzel	Concrete	3	Sod	None
Wisconsin:				
Milwaukee	Concrete	5 on fills, 4 cuts	Dirt and gravel	Header for brick & sandstone, curb for asphalt
Richland	.....	4.5	Earth	.....
Rock	.....	4.5	Earth	.....
Trempealeau	9 ft.	5.5	.....	.....
	15 ft.	2.5	Rolled, sometimes scraped	.....

RESURFACING COUNTY HIGHWAYS

State and County	Kind of pavement resurfaced	Material used for resurfacing	Age of old pavement	Treatment of old surface before adding new material	Cost of resurfacing per mile or sq. yd.	Use made of old materials
Alabama						
Calhoun	Macadam	Chert	5 yrs.	Scarified, shaped, rolled.	$2,500	Used for base
Etowah	.....	Tarvia, surface treatment	6 mos.	None	0.17	None removed
Arkansas						
Jefferson	Gravel	Penetration macadam	3 yrs.	Scarified and surfaced	4,000	None removed
Connecticut						
Fairfield	w. b. macadam	Tarvia B	2 to 8 yrs.	Scraped, holes filled, rolled, tarvia added	2.65	Repairing low spots
Florida						
Brevard	Shell	Shell	3 to 5 yrs.	.....	.....	.....
Dade	Rock	Rock	5 to 10 yrs.	Scarified	1.23*	.....
Hillsborough	Shell	Shell	1 to 10 yrs.	Nothing	.....	.....
Pasco	Macadam	Rock	5 yrs.	Scarified, widened, resurfaced	.....	.....
Illinois					.....	.....
Carroll	Gravel	Gravel	12 yrs.	Nothing	1,000	.....
Douglas	Macadam	Gravel	4 to 8 yrs.	Scarified	900	.....
Lake	Stone and gravel	Stone & gravel, with tarvia	20 yrs. or more	Scarified and shaped	.....	.....
Lawrence	Gravel & macadam	Gravel	3 to 6 yrs.	Scarified	$00	.....
Madison	Macadam	Macadam and Novaculite gravel	8 to 10 yrs.	Scarified and harrowed	3,200	Rerolled with new mat'l
Pike	Gravel	Gravel	10 to 12 yrs.	Scarified and rolled	0.35	None removed
Wabash	Gravel	Gravel	6 yrs.	Grading and draining	1,000	.....
Warren	Gravel	Gravel	12 yrs.	Scarified	0.25	.....
Indiana						
Fulton	w. b. macadam	Gravel	4 yrs.	Scarified and rolled	.....	None
Hancock	Gravel	Gravel	10 yrs.	.....	.....	.....
	Bit. mac.	Tar	.....	.....	.....	.....
	w. b. mac.	Stone chips	5 yrs.	.....	.....	.....
Orange	Gravel	Limestone	12 yrs.	Patched with gravel	1.00	.....
Posey	Gravel	Gravel	20 yrs.	Scarified and resurfaced	5,000	.....
Tippecanoe	Tarvia macadam	Fine stone and tarvia	9 yrs.	Low spots filled with emulsified mixture	325	None removed
Vigo	Bit. macadam	Concrete, 3½ inch, reinforced	10 yrs.	Cleaned and holes filled	3.75	.....
	Brick & concrete	Emulsified asphalt	2 to 15 yrs.	Surface cleaned, cracks filled, loose material removed	1.50	.....
	Gravel	Gravel	10 to 20 yrs.	Graded and dragged	1.00	.....
Iowa						
Emmett	Gravel	Gravel	3 to 4 yrs.	.....	.....	.....
Hamilton	Gravel	Gravel	1 to 3 yrs.	Nothing	1,000	.....
Mitchell	Gravel	Gravel	2 yrs.	Nothing	.57	.....
Scott	Macadam & gravel	Stone & gravel	10 yrs.	Scarified, reshaped, new material added, harrowed	1,000	.....
Kentucky						
Boone	Macadam & gravel	Stone & gravel	5 to 20 yrs.	Scarifying and reshaping	5,000	.....
Henderson	Macadam	Gravel, 6 in .thick	.....	Scarified	.....	.....
Owen	Macadam	Crushed stone	.....	Scarified	.....	.....
Michigan						
Cass	Gravel	Gravel	3 yrs.	None	1,200	.....
Eaton	Gravel	Gravel	5 to 7 yrs.	.....	.15†	.....
Gogebic	Gravel	Gravel	7 yrs.	Gravel hauled and spread in winter, harrowed in spring	.....	.....
Luce	Macadam	Tarvia B and stone	5 yrs.	Filled holes with stone & K. P.	.....	.....
	Gravel	Gravel	4 yrs.	Scarified and reshaped	.....	.....
Mecosta	Gravel	Gravel	6 to 8 yrs.	Scarified and reshaped	'600†	None removed
Muskegon	Macadam	Stone and tarvia	7 yrs.	Scarified and reshaped	2,500	None removed
Schoolcraft	Macadam	Stone, tarvia X, gravel	3 to 5 yrs.	Sprinkled, sometimes scarified	.....	Making fills
Missouri						
Callaway	Gravel	Gravel	7 yrs.	Scarified	1,500	.....
Jefferson	Macadam	Gravel & macadam	10 to 50 yrs.	Scraped with grader	2,000	None removed
Phelps	Gravel	Gravel	.....	Scarified 4 in. deep	.....	.....
New Jersey						
Burlington	Macadam	Asphalt surface	Some 30 yrs.	Scarified and stone added	7,000	None removed
Hunterdon	W. b. macadam	Stone or slag with tarvia B and 65% asphalt	1 to 15 yrs.	Swept, patched with K. P.	.08 to .12	None removed
Mercer	Macadam	Sheet asphalt on 6 in. concrete base	12 and 18 yrs.	(a) Surface skimmed off; (b) macadam removed	2.00§	Filling
Somerset	W. b. macadam	Asphalt	10 to 25 yrs.	Scarified, 3 in. of 1½ stone, rolled, 1½ gal. of asphalt, ¾ in. of stone, ¾ gal. asphalt, rolled.	.....	None removed

New York						
Chenango	W. b. macadam	Bit. macadam	3 yrs.	Scarified and shaped	5,000	None removed
Cattaraugus	Bit. macadam	1:1½:3 concrete reinf.	6 yrs.	Depressions filled with stone	2.84	On shoulders
	Bit. macadam	3 in. bit. macadam	.....	.....	1.09	.....
Lewis	Bit. & w. b. mac.	Bituminous	5 to 8 yrs.	No scarifying. Removed entire surface in some cases	9,000	Filler in foundation course
Otsego	W. b. macadam	Concrete	12 yrs.	Scarified, reshaped, rolled, rebuilt shoulders, cleaned ditches	26,000	For subgrade
Schenectady	W. b. macadam	Concrete	14 yrs.	Scarified and rerolled	5.00	As foundation
North Carolina						
Wilson	Macadam	Stone and tarvia	12 yrs.	Swept clean.	900	None removed
Ohio						
Ashland	W. b. mac., slag mac.	Crushed stone & Slag	6 and 8 yrs.	Scarified and rerolled	.....	None
Carroll	W. b. macadam	Tarvia	7 yrs.	Swept clean	.....	None removed
Champaign	W. b. macadam	Tar cut-back conc.	8 yrs.	Patched with t. c. b., swept with power broom and heavy stable brooms, given paint coat.	.....	None removed
Clark	Bit macadam	Tarvia or asphalt by pressure tank & screenings.	2 to 8 yrs.	Swept with power broom, painted with asphalt, holes filled	.60	Filling
Coshocton	§ Macadam	Monolithic brick	8 mo.	Swept, depressions filled with concrete.	30,000	.....
	† Macadam	Tarvia X	1 yr.	Swept, holes filled with cut-back.	1,200	.....
	Gravel	Gravel	15 yrs.	Shaping with scraper.	.....	None removed
Darke	Bit. macadam	Asphalt and tar	2 to 9 yrs.	.....	.....	.....
Erie	W. b. macadam	Stone and gravel	.....	Nothing	6,000	.....
Fulton	W. b. macadam	Penetrat'n treatment	5 yrs.	Thoroughly brushed with steel broom.	1,250	.....
Hancock	W. b. & bit. mac.	Tar and stone	5 yrs.	Holes filled, new top course	.75	None removed
Highland	Macadam	Tar and gravel	.....	Swept with horse-drawn wire broom	.15	None
Holmes	W. b. macadam	Tar and stone chips	4 yrs.	Patched with t. c. b. and stone.	1,000	None removed
Madison	Bit. macadam	Pea gravel or limestone screenings & tarvia.	2 and 3 yrs.	Patched with t. c. b. and stone.	.08	On shoulders
Muskingum						
Preble	Bit. & w. b. mac.	Tar and hot oil	2 to 5 yrs.	Holes and ruts filled	1,200	.....
Putnam	W. b. macadam	Tar surfacing	3 to 5 yrs.	Swept.	700	.....
Richland	W. b. & tar mac.	Tar and limestone	5 to 12 yrs.	Patched with K. P. and stone, swept clean, tarred by pressure distributor.	900	.....
Sandusky	W. b. macadam	Tar and stone chips	2 yrs.	Swept clean.	.....	.....
Shelby	Bit. macadam	Hot oil	1 yr.	Nothing	1,000	.....
Tuscarawas	Brick	7 in. concrete	13 yrs.	Cleaned	2.00	.....
Williams	W. b. & bit. mac.	Tar and stone chips or gravel	3 or 4 yrs.	Swept with rotary broom and hand brooms. Holes patched with t. c. b. and chips; two applications of tar (⅓ gal. each) and chips or pea gravel.	1,200‡	None removed
South Carolina						
Cherokee	Stone-clay	Screenings and dust	2 yrs.	Scarified	1,000	None removed
Tennessee						
Hamilton	Chert	Asphalt oil	3 yrs.	Holes leveled up.	.12	.....
Vermont						
Bennington	Gravel	Gravel	4 to 7 yrs.	Nothing	2,112	.....
Virginia						
Augusta	W. b. macadam	Asphalt	1 to 10 yrs.	Swept and patched	.....	.....
Fairfax	§ W. b. Macadam	Bit. macadam, 3"x14'	5 or 6 yrs.	A few sections scarified; rest not disturbed	12,000	None removed
	† Gravel	Gravel	5 or 6 yrs.	.....	.....	.....
Henrico	Gravel	Gravel, 3" to 8"	3 yrs.	Scarified and shaped	2,500	None
Pittsylvania	W. b. macadam	Bit. macadam	11 yrs.	Nothing	2.25	.....
Wise	W. b. macadam	W. b. macadam	5 yrs.	.....	.75	None removed
Washington						
Lincoln	§ Macadam	Fine crushed gravel	5 yrs.	Scarified	1,200	None removed
	† Gravel	Fine crushed gravel	2 yrs.	Scarified	1,200	None removed
West Virginia						
Harrison	Bit. macadam	Tarvia X and K. P.	5 yrs	Thoroughly swept	.....	None
Mercer	W. b. & bit. mac.	Limestone & oil or tar	4 to 5 yrs.	Surfaced	1.40	None
Mineral	Bit. macadam	Limestone chips & tar	3 yrs.	Swept and repaired.	200	For shoulders
Wisconsin						
Grant	Macadam	Bit. macadam	10 to 12 yrs.	Leveled up with stone	1.01	None
Juneau	Macadam	Road oil & pea gravel	5 yrs.	Scarified	.20	None removed
Milwaukee	Concrete	Asphaltic concrete	7 yrs.	Thoroughly swept, removed old tar, widened concrete 6 ft.	2.06**	None removed
Rock	Gravel	Gravel	5 to 10 yrs.	Scarified and rolled, rebuilt shoulders	1.920	For base
Trempealeau	Macadam	Gravel or stone	5 yrs.	.....	2.500	For base
Walworth	W. b. macadam	Crushed gravel	6 to 8 yrs.	Scarified	2,000	.....

*Per cubic yard of new shell. †For gravel. §For sheet asphalt, 1½ in. top on 1½ in. binder. ‡Does not include patching holes. State applied tar at cost of 6⅔ cts. per square yard. **For the asphaltic concrete; includes cost of extra thickness where concrete was badly worn.

MAINTENANCE OF WATER-BOUND MACADAM COUNTY HIGHWAYS

State and county	Miles in the county	Average width, in ft.	For a period of years: Amount spent for maintenance in 1919.	Average spent per mile per year.	Number of years averaged.	Travel on the roads in question, average per day.
Alabama:						
Calhoun	10	10	$200	25	5	100 motor cars
Etowah	15	16	Nothing	200*	4	200 wagons and cars
California:						
Plumas	350	10	20,000	....	....	Motor vehicles 9 mos. snowbound 3
Florida:						
Pasco	6	16	....	300	....	.....
Illinois:						
Carroll	20	12	5,000	....	....	.....
Douglas	35	10	5,000	100†	5	.....
Kane	30	12	....	500	....	.....
Lawrence	6	12	....	500	6	500 pleasure cars to 10-ton trucks
Madison	22	12	7,000	675	6	No data
Monroe	8.5	16	200	30	....	100
Pike	8	16	750	....	....	100 to 250 motors
Indiana:						
Adams	573	14	74,444	40§	10	.....
Jennings	280	10	20,000	60	....	.....
Shelby	30	12	....	100	3	Motor travel principally
Vigo	2	9	2	25	10	500, 1 to 7 tons
Iowa:						
Scott	60	12	5,000	100	5	300 per day, average 1½ tons
Kentucky:						
Bell	20	12	Nothing	Nothing	3	To be surface treated this year
Boone	30	10	30,000	100	1914-1917	
				300	1917-1920	50 38-ton
Rockcastle	7	9	200	....	....	50, average 1 ton
Whitley	10	14	....	Nothing	2	10 autos, 3 trucks, 15 wagons
Michigan:						
Alger	30	16	28,000	75	1	200
Luce	10	16	6,000	110	....	175 pleasure cars
Marquette	13.8	15	6,551	....	....	.....
Muskegon	40	12	60,000†	500†	3	1,200 autos
Schoolcraft	35	16	10,000	300	3	300 cars, 10 trucks
Minnesota:						
Big Stone	138	24	6,000	60	6	120 vehicles
Crow Wing	3	16	700	150	4	400 cars
Missouri:						
Callaway	7	9	200†	25†	4	300, average 2 tons
Jefferson	0.5	9	10	12	10	Autos and heavy trucks 100
Lincoln	25	10	Nothing	100	15	
Montana:						Heavy trucks and
Beaverhead	4	20	Nothing	....	....	tourist travel
New Jersey:						
Burlington	150	14	....	1,500‡	....	Heavy
Hunterdon	70	16	70,000	500 to 1,000	....	100 to 200 autos
Mercer	40	16	1,588**	....	....	.....
Passaic	155.1	20	269,820	1,100	2	Fairly heavy
Somerset	120	13	82,000	500	10	400 autos averaging 3 tons

Forgotten Items in Contracts

In a recent paper by D. S. Colburn, published in the *Contractors' Atlas*, the author analyzes the cost estimate of a 130 x 200-foot three-story school building for which the usual items of labor and materials, plus 10 per cent profit aggregated $139,243.96, and showed how the contractor stood to lose nearly all of his legitimate profit by overlooking a number of ordinary vital expenses that go to make up the necessary general cost or overhead expense.

These consisted of bonds, fire insurance, liability insurance, telephone, traveling expenses, temporary office, water supply for construction purposes, watchman, time-keeper, engineer for laying out, etc., protection of work, temporary heating, cleaning building, carting debris, and cutting and jobbing for other trades, making a total of $9,005 which, plus the original estimates and the 10 per cent profit on the whole, made the correct bid $149,149.46.

Even this addition is inadequate because neither estimates provided for interest on capital, office expenses, salaries, cost of estimating, waste deterioration of plant, loss of tools or contingencies which together should be provided for by several thousand dollars more according to the magnitude and nature of the contractor's total business.

Salt Water for Concrete

From observation made on concrete subjected to a moist tropical climate it is believed that the use of salt water for mixing the concrete in such localities is especially objectionable. In reinforced concrete elements and in sea walls made with salt water the steel began to rust within a few months and soon caused the formation of cracks, distortion, and discoloration of the concrete, apparently indicating a very short life for the structure which was at first in very good condition.

Heavy Side-Hill Cutting

Heavy grading for the construction of the 33-mile Dixon-Polson, Montana, branch of the Northern Pacific Railway was carried on by a Marion steam shovel working a side hill cut as deep as the boom could operate and loading directly into 10-yard side dump cars hauled in 10-car trains by a dinky

MAINTENANCE OF WATER-BOUND MACADAM COUNTY HIGHWAYS (Continued)

New York:						
Chenango	6	12	1,200	100	8	.....
Cattaraugus	10.3	16	1,152	....	....	.....
Chautauqua	4.1	16	1,712	....	....	.....
Erie	85.9	12	681	....	....	.....
Niagara	23.7	16	828	....	....	.....
Lewis	21.1	16	6,300	360	2	242 autos, 20 trucks, 25 1-horse and 23 2-horse vehicles
Otsego	81	16	....	500	5	150 motor, 20 horse
Schenectady	31	14	25,600	....	....	250, average 1.5 tons
North Carolina:						
Union	4	10	None	....	....	75-light to medium
Wilson	20	14	900	600	2	100
Ohio:						
Ashland	28.2	12	30,000	4,000	8	Motor cars
Carroll	9.5	16	1,800	200	3	.....
Champaign	16	13	14,000	350	8	.....
Fairfield	15	12	60,000	300	5	.....
Fulton	122.7	14	47,148	400	....	.....
Hancock	739.3	10	10,000	....	....	.....
Highland	163.3	14	16,000†	60	5	.....
Jefferson	240	10	65,000	....	....	.....
Madison	17	14	2,000	120	4	.....
Putnam	637	10	134,400	150	5	.....
Richland	32	10	15,000	....	....	.....
Sandusky	490	10	30,000	....	....	15
Tuscarawas	22.4	16	2,200	....	....	100 touring cars
Tennessee:						
Cocke	100	12	25,000	100	5	200, average 4,500 lbs.
Hamilton	4	16	....	600	....	.....
Virginia:						
Augusta	80	12	25,000	230	5	.....
Campbell	2	14	300	250	3	100 autos and wagons
Fairfax	20	12	10,300	....	....	11 miles heavy, rest moderate
Pittsylvania	24	14	15,600	....	....	.....
Scott	40	12	30,000	900	3	.....
Wise	80	11	30,000	....	....	200, all kinds
Washington:						
Lincoln	16	16	3,000†	200†	6	90 per cent. motor
Wisconsin:						
Adams	3	9	600	150	3	.....
Brown	200	9	60,000	....	....	500 cars
Door	200	9	30,000	150	....	.....
Juneau	35	12	8,096	231	....	160, average 3,000 lbs.
Richland	12	9	8,000	660	2	.....
Rock	10	9	1,095	100	3	.....
Trempealeau	2	9	....	300	8	Heavy

Note: Unless otherwise stated, maintenance costs given include only labor and material.

*Includes overhead charges. †Maintenance costs include machinery upkeep and depreciation. §Now $110 a year. ‡Includes some overhead and some equipment. **Includes administration and truck maintenance.

locomotive and dumped from timber trestles permanently embedded in the high embankments. In order to install the dinky locomotive well in advance of the track-lying, it was chained and blocked on a pair of track rails mounted on a heavy truck and hauled a long distance across the country by a 10-horse team.

Preventing Pavement Deterioration

Editor, Public Works, New York City.

Dear Sir:

I have just read the article, "Resurfacing Old Pavements," in Public Works, issue of February 7. I agree with you almost entirely as to the suggested practice in such cases as described in that article. But confessedly I am impressed more deeply over the conditions found than the manner and method of repair. By this I do not mean that the manner and method of repair of conditions existing is not without deep concern, and inasmuch as we have that to contend with, a study of the best treatment is of course not out of place. But is it not the proper thing also to take into consideration what may be done to prevent a recurrence and growth of conditions such as this article discloses?

So this question comes to me while I am reading this article: Where non-uniform surface wear is found, a generally accepted theory is that it is due to the non-uniformity of the wearing material, whereas a close study of the conditions will in most cases, especially so in our smaller cities and on country highways, disclose the fact that the excessive wear is due to defective or non-uniform support of the wearing surface —the primary cause being found in the sub-structure.

Perhaps my recent plea for a better understanding of our sub-structure conditions and, if possible, a classification of soils which may characterize their absorptive and capillary qualities for the retention and absorption of moisture, is the influence that causes me to write you this letter. If we better understood this soil quality, the second step might be easily applied, namely, the necessary treatment to stabilize it. If, therefore, we knew what we were dealing with and could treat our sub-structure conditions efficiently and sufficiently to furnish adequate support to the wearing surface of our pavements, the injury which calls for millions for resurfacing purposes would be limited to the friction of abrasion wear from the traffic. If this vision or possibility could be realized, it is not difficult to conceive millions of dollars that might be saved.

A good many agencies are at work upon this problem. Ultimate success in solving it depends upon the persistency and energy and the financial means to pursue.

Let us hope for early results.

Yours very truly,

WILL P. BLAIR,
Vice-President, National Paving Brick Manufacturers' Association.

The Nation-wide Demand for Improved Highways

At a regular meeting in New York, March 17, of the American Society of Civil Engineers, the subject of the nation-wide demand for improved highways was covered by a program including addresses from a number of men identified with road construction, including highway officials, consulting engineers and others who have had large experience and spoke with authority. The principal topics were: A General Survey of the Highway Situation; An Historical Sketch of Traffic and Types; How Much Can We Afford to Spend for Highways Per Mile?; Permissible Cost Based on Saving in Hauling; The Need for Adequate Maintenance—Its Bearing on First Cost; Suggestions on How to Complete the 1920 Program of Highway Construction; and Permanent Highways as an Aid to Railroads.

The discussion was opened by H. G. Shirley, secretary of the Highway Industry Association, Washington, D. C., whose text was the Nation-wide Demand for Improved Highways. Mr. Shirley enumerated 24 states that had either provided for, are about to provide for, or are legislating to permit the appropriation of large amounts of roadway funds varying in some specific cases mentioned from $25,000,000 in Mississippi to $90,000,000 in Minnesota and $100,000,000 in Texas. Although these sums aggregate a large amount, it is very small in comparison with what is needed.

MORE THAN 2,000,000 MILES OF ROAD IMPROVEMENT REQUIRED.

There are in this country about 2,500,000 miles of roads, not more than about 10 per cent of which can now be called good roads. During the last ten or fifteen years these roads have been subjected to a traffic ten times as fast as the former traffic, due to the use of 7,000,000 automobiles that at a low estimate will increase 1,000,000 vehicles a year at the present time. New roads are being opened and partly completed at the rate of about 55,000 miles per year, but they are really being finished only at the rate of about 5,000 miles per year when they should be constructed at the rate of at least 20,000 miles per year as the first job before the American people.

We must not think that we are now meeting and solving this problem; it is fully equal to the original railroad problem, and with the aid of the engineers, it must be solved within the next ten or twenty years if we wish this country to develop as it should. We will then have, with Federal aid, a system of national roads connecting with the main centers of population, passing through the productive areas, and connecting the isolated districts

We must certainly pay for our roads, and in payment should remember that money is only a medium of exchange and that today a man's labor will build just as many square yards as it ever did, that a bushel of corn will pay for just as much road as ever, and that we are as well able as ever to build now, even with inflated prices, as at any previous time.

Today there is being built a standard type of road in Delaware and roads with the same thickness are being built on gumbo soil in Illinois, over the shell cliffs of Wyoming, and in other places where the conditions are different. Therefore it is the problem of the engineer to make the best roads for the conditions encountered.

TRAFFIC AND TYPES.

W. G. B. Thompson, state highway engineer of New Jersey, reviewed some of the ancient historical roads commencing with the Appian Way, 125 miles long, which was built by the Romans nearly 2,300 years ago and is still in service. In this country the trails of early days were succeeded by clay and gravel roads developing under heavier traffic into Telford foundations of large stones packed by hand. Later they were provided with crushed stone surfaces forming macadam roads that, since the introduction of automobiles, have been treated with tar and asphalt surfaces in the interurban and rural districts as distinct from city pavements. The present problem is to devise a road that with different kinds of foundations, will be durable under the heavy traffic of automobiles and automobile trucks. The remarks were illustrated by a number of views on ancient and modern highways and bridges.

HOW MUCH CAN WE AFFORD TO SPEND FOR HIGHWAY PER MILE?

E. J. Mehren said that it is impossible to give an answer to this question since it always depends on conditions. It is, however, safe to say that road construction is not justified where its annual carrying charge, plus its maintenance, much exceeds the cost of maintaining the existing roads.

Before the war an annual maintenance charge of $750 per mile was not considered excessive and a pretty good concrete road 16 or 18 feet wide could be built under ordinary conditions for as little as $15,000 per mile. Now under abnormal conditions

of construction and financing, it may be possible to build the same road for $20,000 per mile, giving an annual charge for the first year of about $1,900 per mile. Comparing this with the former charge of $750 for maintenance, there is a balance of about $1,100 a year in favor of maintaining the old roads.

At the present time the cost of building new roads is about 2½ times as much and the cost of maintenance about twice as much as before. I think that we should go slowly until the expense of road building comes down. The question of road building is wholly one of policy, to protect the public in spending its money efficiently. There is a general movement to restrict highway building.

PERMISSIBLE COST BASED ON SAVING IN HAULAGE.

George H. Pride, of the Heavy Haulage Co., said that road construction is the biggest enterprise that the world has even seen and to which the Panama Canal was a mere bagatel. The road engineer is not to be looked upon as a wonderful magician, but as a man who is spending our money, and what is he giving us for it?

The road must not be considered separately, but in connection with the vehicles that are operated on it. With a 5-ton truck under ordinary conditions, the average ton-mile cost of hauling, properly calculated, is about 25c.

When a traffic of 500 tons of freight in 24 hours can be assured for a road, it will mean, under present conditions, a saving of $19,000 a year on railroad rates, which would certainly justify the construction of very high cost roads. Besides this, the 7,000,000 pleasure automobiles would easily save $100 a year by running over good roads instead of poor roads.

Traffic is a wonderful business barometer and if a new road shows a heavy increase of traffic, it demonstrates the prosperity of the community. The owner of a motor truck may be accused of damaging the roads, but in reality he is very anxious to cooperate in their improvements and maintenance.

In certain sections of the south, land worth $15 an acre immediately increased in value to $20 or even $30 an acre when bond issues were authorized, even before any operations were actually undertaken for road building.

Road building cannot be stopped, the engineers must carry it on when it is demanded, and notwithstanding the high prices it would not probably be now suspended in Illinois if it were possible to be assured of materials and labor. So far, roads have been built with different kinds of aggregate, but now it is desirable that the use of steel should be seriously considered to make some sort of track.

THE NEED FOR ADEQUATE MAINTENANCE, ITS BEARING ON FIRST COST.

H. Eltinge Breed, consulting highway engineer, said that it was important to keep the roads in condition to function properly by attention to the drainage whenever soil conditions are bad, by a constant patrol system, and by reconstructing the surface whenever the annual maintenance becomes overburdensome in cost and when there is great loss of time in carrying on maintenance work, as for instance, when it is necessary to detour 500 cars a day one mile around a piece of reconstruction which will cost $30 a day or $3,000 for 100 days, which is not too long to allow.

Maintenance work should be completed early in the season and much is facilitated by an adequate budget with full details. When New York State commenced to build roads in 1909, a million dollars was appropriated for their maintenance and the amount has fluctuated since then up to $5,000,000 for maintenance in 1919. These appropriations were, however, from 30 to 50 per cent less than the amounts requested, and today the state is in need of enormous maintenance expenditures. It is, therefore, the duty of engineers to make accurate estimates of the cost of the work and for the public to support them in receiving the full amount needed. The high cost is largely due to the presence of traffic different from that for which the roads were originally designed, and to the congested condition of inadequate roads. The proportion of motor traffic increased from 15 per cent in 1916 to 30 per cent in 1918 on trunk lines near New York City, in the Susquehanna Valley, and in Western New York.

SUGGESTIONS ON HOW TO COMPLETE THE 1920 PROGRAM OF HIGHWAY CONSTRUCTION.

H. E. Hiltz, principal assistant engineer of the Pennsylvania State Highway Department stated that the $110,000,000 at present available for the primary road system in Pennsylvania will be used with the intention that the road shall be built so as to outlast the life of the bonds, and have something to start with after the 20-year period. Maintenace costs are paid for by automobile taxes.

We make full use of newspapers to speed up the work, sending them for publication maps of detours and information about new improvements, the kind of traffic, location, sub-constracts, prices and the like, and we also send special information to large users of the roads.

An engineering paper recently commented on the high prices paid for road building in Pennsylvania and all of the state contracts were forthwith analyzed by four men, one of them from the standpoint of the business man, the second from that of the contractor, the third from that of the engineer, and the fourth from that of the expenditure of public money. One contract at $60,000 per mile was for a vital link in a main line road where no road existed and rock excavation of from 30 to 80 feet was encountered. Another contract at $40,600 per mile was at a place where the roads at certain seasons were absolutely impassable. A third contract at $93,900 per mile is in a borough street requiring a pavement 30 feet wide with 20-inch curbs on both sides costing about $52,000 per mile.

All of this year's program was laid out and surveys completed last year for primary improvements this year. All of the inspectors were retained, put on survey work and in the winter doing sliding work so that the organization was ready to handle 400 contracts to be in force on May 1st. In these days when a contractor is paying from $300 to $500 a day for his gang, he does not wish to wait for decisions on specifications and the latter must therefore be clear and decisions should be made immediately.

We believe in the development of local supplies

of stone and sand and not only examine but thoroughly test both materials by opening sand pits and by blowing out ledges and in this way our testing department has developed local supplies aggregating 600,000 cubic yards of stone. We list the supplies to the contractors and are glad to have them utilize them even though they may bid at a rate of perhaps $2.00 a ton when they get out the aggregate at $1.25 per ton.

In designing the roads of the primary systems the type is made to conform with the local conditions, as for instance in building sheet asphalt or bituminous concrete on brick bases, concrete bases or reinforced concrete bases according to local conditions.

In order to speed up the work, the contractor must furnish, before he receives award, assurances of his satisfactory equipment and finances. The department makes out a list of equipment needed for a certain contract and the bidder is informed that he must provide himself with it.

In some departments the contractor is required to have financial resources of 20 per cent of the contract, thus giving him sufficient capital to buy his materials and carry on the work before the monthly estimates come in. On the original contract the industrial system eliminates poor labor and the best contractors do not hesitate to pay high prices for satisfactory men; one of them starting his work last September with $7 labor accomplished more than others who commenced the first of May with $3.50 labor.

Labor turnover is a very serious problem but the payment of $6 and $7 a day and the installation of industrial equipment almost eliminate it. In Pennsylvania where we have many hills we find that from 4 to 6 miles is the most economical section of road to be finished in one working season. The providing of mechanical equipment for road construction is a very important consideration and should be handled by engineer salesmen for the manufacturers. In many cases, the work is examined by the representatives of the equipment people and vital information is given to the contractor before he makes his bid.

PERMANENT HIGHWAY AS AN AID TO RAILROADS.

Robert S. Parsons, New Jersey State Highway Commissioner and chief engineer of the Erie Railroad, said that permanent highways are of unquestionable aid to railroads by relieving them from unprofitable traffic which they must otherwise serve. Permanent highways should be used as branch lines, as connectors of miscellaneous freight in general, to relieve railroads of short-haul traffic in congested territories surrounding cities, to supplant waterways where boat traffic is extraordinarily expensive, to enable motor trucks to perform service, and for the development of inland freight stations.

In many cases it might pay to tear up branch railroads and use their road beds for the construction of highways which would not only serve the trunk line as well as the branches, but would also provide public highways. Trucks run on them from loading to unloading points save handling.

A method might be developed by which railroads could well afford to furnish trucks to operate for nearby towns to railroad stations. When railroad facilities in towns become congested, they may sometimes be relieved by the elimination of short-haul freight by the use of motor trucks that would deliver the freight assigned to the town within a radius of about 30 miles and carry truck farm products on the return trips. A very costly lighterage in New York eats up the entire profit on all short-haul traffic there, may be greatly relieved by the use of motor trucks operating direct from the New York warehouse to the New Jersey car yard for which purpose the proposed Hudson River Vehicular Tunnel may be classed as a permanent highway.

The so-called ferry car moving from door to door of various plants to assemble miscellaneous loads and carry them to a transfer point where they are separated for their final destinations is a losing proposition and the work could better be performed much more cheaply by motor trucks over a good road.

Very expensive development of freight tracks and grade crossings may be eliminated by establishing on cheap vacant property freight sheds containing removable truck bodies that can receive all the freight originating in that vicinity, be moved to a central station in the railroad yards and there loaded on cars and run to the proper destination.

Submerged Gravel Storage

In providing for a large winter storage of gravel under water, the Granite, Sand & Gravel Co., Indianapolis, Ind., have utilized an exhausted gravel pit, provided for the extension of gravel excavation beyond former limits, have completely utilized the established screening plant without change, have reduced the cost of excavation, have separated their plant into two independently operating units reducing overhead and waste expenses, and have increased their total capacity of production from 10 to 15 carloads per day.

The original plant consisted of a cableway about 600 feet long on which was operated a 2-yard Sauerman dragline bucket that had excavated, to a depth of 40 feet below water level, an elliptical area about 500 feet wide and 1,200 feet long and had delivered the gravel to a screening and loading plant adjacent to the railroad track at one end of the cable.

After six years' operation, the dragline excavator had reached its limits and some other methods had to be devised for excavating the gravel and delivering it to the screening plant. A floating 1¼-yard clamshell dredge was therefore installed in the pool and attacked the edges of the banks beyond the reach of the dragline bucket. The overburden, averaging 3 feet, is allowed to fall into the water when the bank is undercut, thus saving a stripping cost of about $2,500 per acre. The clamshell delivers to a 60-yard bottom-dump barge moored alongside which is propelled by a gasoline engine and transports the gravel to the center of the pool and dumps it under the cable where the dragline bucket reclaims it and delivers it, a distance of 200 or 300 feet, to the screening plant where it is handled at the rate of about 2 yards per minute. By this arrangement, the excavation and storage of

gravel can go on continuously whether the screening plant is operated or not, and a large accumulation of gravel may be held in readiness for any demands.

Argentina's Public Improvements

Various projects of importance in Argentina are in progress. Floating docks, costing more than a million and a half dollars, are to be built by the government at various ports on the Parana, Paraguay and Uruguay rivers. An appropriation of $820,000 has been made for harbor improvements at Rosario.

Water service is to be provided in all communities having a population of 3,000 people or more, and both sewer and water service for all towns of 8,000 or more inhabitants, at an estimated cost of 15,000,000 pesos. A Portland cement factory, with a capacity of 300,000 tons annually, is to be established.

Work on the Rio Negro irrigation project, undertaken by the Buenos Aires Great Southern Railway, is reported to be progressing. About $5,000,000 is to be expended in this enterprise, which aims at the irrigation of about 325,000 acres.

Pitch pine water pipes 16 inches in diameter bored with 2-inch and 4-inch holes were laid in Boston in 1789, used continuously 51 years, and dug up in good condition after 130 years.

Natches- Selah Irrigation Works

Nearly seven miles of conduit built and repaired, including trestle and terrace flumes; lined canals; and 8,718 feet of lined rock tunnels, all concreted from several mixing plants supplied with aggregate dredged from adjacent river bed.

The Natches-Selah Irrigation System in the Yakima Valley, Washington, serves about 10,500 acres of orchard land by a long conduit carried through a mountainous region in tunnels, flumes and canals. The work includes the reconstruction of somewhat less than 3 miles of the original waterway and the building of nearly 4 miles of new structures. On this project there have been constructed since May, 1918, 8,718 feet of new tunnels, 3,100 feet of canal linings and 1,200 feet of flume both of reinforced concrete that were completed ready for service April 1, 1919. The work was designed and directed by Elbert M. Chandler, chief engineer, and was executed on the cost-plus-fixed-sum basis by the Nettleton Bruce Eschbach Co.

FLUMES.

The flumes are of two types, those seated directly on the bench terraced out of the side of the mountain, and those supported on trestle bents spaced 10 feet apart. The cross-section of the trough in both types is alike except that the bench flumes have an inside depth of only 5 feet, while that of the trestle flumes is 6 feet. They are designed to have a freeboard of 12 inches and a capacity of 135 second feet. The upper edges of the walls are tied together with tension-struts 6 feet apart and the walls and bottom are reinforced with 4 per cent of round steel bars. The concrete was mixed very wet and was poured continuously until each flume was finished.

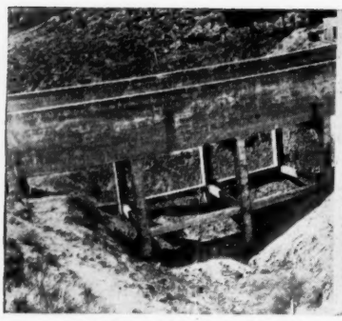
The flumes and the canal linings were made with concrete mixed with aggregate from a bar in the stream, crushed when necessary, and delivered to the mixers at various plants located at convenient places for the different sections of the work.

CANAL LINING.

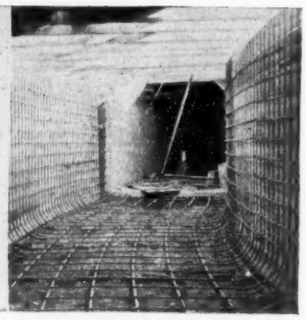
The canal, some of which is a revision of the old canal, has a regular cross-section so as to conform as nearly as possible with average conditions and made with sloping sides and sloping bottom cov-

MIXING CONCRETE FOR CANAL LINING IN PORTABLE MACHINES, AND DELIVERING IT ON PLANK RUNWAYS.

LINING BOTTOM AND SIDES OF CANAL WITH REINFORCED CONCRETE.



FLUME ON CONCRETE TRESTLE.



REINFORCEMENT IN PLACE FOR FLUME.

ered with 3 inches of concrete reinforced by 12 x 12-inch Clinton wire mesh made with No. 12 wire embedded 1½ inches from the surface. Transverse construction joints 5 feet apart longitudinally were scored ½ inch deep to fix contraction cracks.

In general the canals are in adobe or other soil that retains the moisture and on previous work has caused much trouble with frost. In order to prevent as much as possible temperature cracks the 1: 2: 4 concrete was placed in cold weather so that any cracks will close by expansion in summer time.

The wire mesh in rolls a little more than 6 feet wide was laid in longitudinal strips, two on the bottom and one on each side, and tied together on the edges with wire projections from the sides of the strips. The concrete was placed in two courses, plastered on the bottom and sides of the canal like mortar with the reinforcement placed on top of the first course and covered by the second course.

Aggregate and cement bags delivered alongside the canal by motor trucks were stored in heaps adjacent to the portable mixers with elevating charging hoppers that were moved at frequent intervals as the work progressed. The mixers discharged through open chutes supported at the lower end on light wooden towers where the discharge was controlled and the concrete delivered to two-wheel carts, pushed by hand over plank runways, dumped as required and shoveled and raked to position.

The cost of preparing the subgrade and building the lining averaged $2.66 per linear foot, equivalent to $0.66 per square yard of surface. The cost of the concrete lining in place including the reinforcement was $5.79 per linear foot, allowing $23.16 per cubic yard for concrete. Laborers received from $4.50 to $6.00 per day and were of inferior quality.

TUNNELS.

The tunnels have a horizontal floor, vertical side walls and segmental roofs with 2-foot rise. The uniform width of 7 feet was the most practicable minimum for construction operations and the height of the side walls varied from 4½ to 5 feet, according to grade. Except in timbered sections the concrete lining was generally 6 inches thick with a 4-inch floor over rock bottom.

With one exception, of a tunnel only 1,082 feet long which was through cemented gravel and large boulders, all of the eight tunnels aggregating 8,718 feet in length, were driven through soft dry sandstone or shale in which the holes for blasting were made with coal augers. The tunnels were driven in full size headings. At one time the double shifts on the double headings of five tunnels required twenty gangs that made an aggregate advance of 140 feet per day. The muck was hauled by mules and the tunnel was lined as soon as possible, because, although the rock stood well when first blasted, a long exposure made it very treacherous

CONCRETE PLANT.

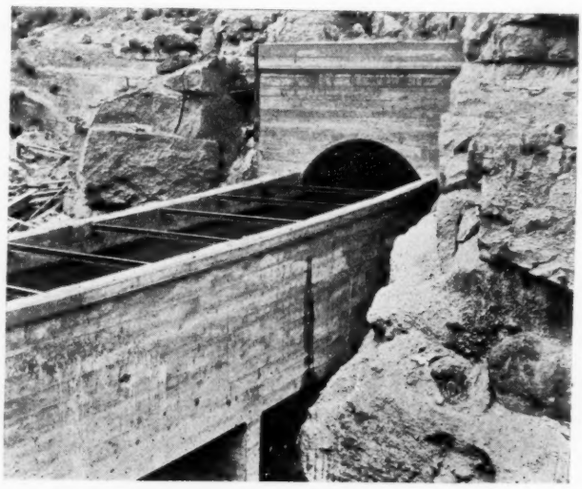
Concrete was made with sand, gravel and crushed stone all dredged from the river bed with a 1½-yard dragline bucket operated from a 60-foot derrick boom. The sand was washed through the screens by a 2-inch centrifugal pump providing enough water to facilitate the loading into trucks by which it was delivered to the concrete mixers. Large stones were broken in an electric jaw crusher and the three storage bins were mounted on rollers and advanced by anchored tackles operated by the hoisting engine of the derrick whenever the extension of the pit required a movement to be made, usually every other day.

The derricks were similarly shifted on greased skids and hauled forward by the same tackles, these movements requiring about two hours. The plant was operated twelve hours a day by a five-man gang.

One of several mixing plants was installed on the top of a good sized hill that enabled the trucks to dump aggregate directly into the storage bins which delivered by gravity to the two-bag machine that was operated by one man and discharged through an open chute 150 feet long terminating with a spout to the portal one hundred feet vertically below it.

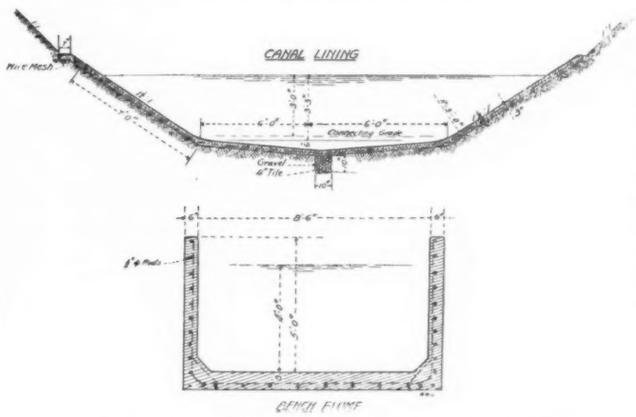
TUNNEL LINING.

Two 6 x 2-inch longitudinal strips of concrete were laid on the sides of the tunnel floor to support the wall forms and after the invert between the strips was concreted, the sectional wooden forms that were removed before the wooden arch forms were set, were wedged to position. The 4-foot sections of arch were concreted and rammed in about one-half hour by a four-man gang. The



FLUME AT TUNNEL ENTRANCE.

total cost of lining exclusive of engineering, including cost and contractors' compensation, was



STANDARD CROSS-SECTIONS OF FLUME AND CANAL.

$103,834, averaging $23 per cubic yard. The total cost of the finished tunnels was $175,307, averaging $20.10 per linear foot. The inefficient labor received $4.50 per day.

Sacramento Valley Water Conservation and Irrigation

Up to 1917, the average flow of the Sacramento river has been 25,000,000 acree feet or more annually, but since 1917 it has been reduced to 14,000,000 acre feet or less, an amount that is still abundant for all needs if it is properly conserved. There are sites in the mountains for adequate reservoirs, but they have not yet been surveyed or developed and the details are not known, although it has been concluded that the big valley in Lassen County, which has long been considered an ideal reservoir site, is impracticable because the run-off would not be sufficient to fill in many years.

Frank Adams, irrigation expert in the United States Department of Agriculture, has presented a scheme for the organization of districts and the immediate construction of dams and reservoirs with state appropriations to be later repaid by assessments paid on the benefits of reclamation and irrigation in the flood control districts.

Col. R. B. Marshall, former geographer of the U. S. Geographical Society, has outlined a plan for a great system of canals covering the valleys from Shasta to San Francisco, at an estimated cost of $1,000,000,000, which would insure an abundant supply of water throughout the state at all seasons of the year and the cost of which would be more than repaid by charges levied on consumers after they had raised the first irrigation crop and were experiencing the benefits of the improvement. This scheme is expected to bring under cultivation millions of acres of land that are at present nonproductive. The California Water Congress passed a resolution unanimously calling upon Gov. Wm. E. Stevens to summon a special session of the Legislature to consider the water problem in the Sacramento Valley.

Deterioration of Labor

Contractors and other employers have long known that the quickest and surest way to demoralize and impair labor is to overpay it. Overpayment makes most men conceited and arrogant and not only breeds carelessness and indifference to their work but, by giving them larger resources, without provision for their wise disposal, permits them to enjoy more idle time and to indulge in extravagances and viciousness that unfit them for their work and decrease their ability as well as their inclination, thus affording the most convincing proofs that, for the best good of all concerned, every man should be paid according to his actual efficiency measured by direct products or total results.

The overpaid laborer is generally discontented, lazy, and ripe for trouble, despising, with more or less reason, the employer that submits to his insolence.

Disproportionate and unaccustomed wages, far from increasing efficiency, invariably decrease it, thus multiplying instead of reducing unit costs. This is demonstrated in a remarkably graphic manner by the accompanying picture, received from Bent Brothers, contractors, Los Angeles, of a scene on their job of installing a 42-in. concrete pipe at Oklahoma City. Here it takes nine men, at $4.50 per day, to handle a single section of the pipe that in 1916 was handled more rapidly and efficiently by three men at $2.50 per day.

The nine men do poorer work and do it slower, getting in each other's way, interfering, stopping to rest and talk and requiring much greater transportation, supervision and general expense than would three men. Note the gentle exercise shown in the picture; not a single back bent to honest work, no evidence of energy or efficiency, the men standing erect and indifferent and so numerous that they cannot even find room so that three of them are, quite suggestively, actually backing away from the work.

For the same gang the total daily wages have increased from $7.50 to $40.50 per day thus multiplying the nominal cost five and one-half times to

NINE MEN DOING WORK THAT THREE SHOULD DO.

say nothing of the additional difference caused by less and poorer work. Labor that gives such a return for such payment is playing the role either of a pauper or a robber or both and should be treated accordingly.

Protecting Contractors Against Rising Prices

In a contract to be let by the North Jersey District Water Supply Commission provision is made for changing the amounts to be paid the contractor to protect both him and the District against fluctuations in the cost of labor exceeding ten per cent.

The emergency work done by the Federal government in preparing for and conducting the war, and later the unusual conditions manifested in the rapid and considerable increases in wages and costs of materials, have resulted in a more or less general adoption of new ideas or modifications of old ideas in the awarding of contract work. Among these may be mentioned the several variations of cost-plus contracts.

More recently the innovations have been for the purpose of arranging between contractors and parties of the first part terms which shall enable contractors to bid upon work without either making an unduly high allowance in their bids for possible future increases in cost of labor and material or, on the other hand, incurring the possibility of bankruptcy through failure to sufficiently take into account such probable increases. In most cases this end is met by providing that the contractor shall be recompensed for certain classes of increases which may take place after the awarding of the contract, such increases including wages, freight rates, etc.

One of the latest contracts embodying such a provision is that prepared by the North Jersey District Water Supply Commission for the construction of the Wanaque dam, bids for which are to be received on April 27. This work involves a cost of more than $1,000,000, and comprises the construction of an earth dam and concrete and clay-puddle core wall. The particular feature of the contract referred to is quoted herewith in full, because of the interest which it may have for others who are contemplating making similar provisions in work about to be contracted for.

It will be noted that this article refers to wages only, and makes no provision for changes in freight rates. Most of the cost of the work, however, will consist of labor, the principal materials to be brought by rail being estimated at 140,000 barrels of cement, about 500,000 pounds of iron and other metals, and comparatively small amounts of pipe, lumber, etc. The article referred to is as follows:

Payment for Wages Above or Below Stipulated Rate.

Art. XL. To the end that the Contractor and the Commission may be protected, in so far as is practicable, against extraordinary fluctuations in the cost of labor, the Contractor shall make his bid on the basis of the following base scale of wages which is given on the information available to the Commission as the prevailing rate in Newark, N. J., upon the date of advertising this contract:

Trade or Occupation.	Base Scale of Wages.
Steam shovel man	$250.00 Month (26 days)
Craneman	50.00 Week (6-8 Hr. days)
Carpenter	8.00 Day (8 Hr.)
Mason	9.00 " "
Mason helper	5.60 " "
Concrete finisher	9.00 " "
Plumber	9.00 " "
Drill runner	7.00 " "
Tool sharpener	7.00 " "
Tool sharpener with pneumatic tool	7.50 " "
Pipe fitter	8.00 " "
Pipe fitter helper	6.00 " "
Engineman or engineer	46.00 Week (48 hours)
Fireman	150.00 Month
Rigger	8.00 Day
Machinist	1.00 Hour
Pile driver operator	50.00 Week
Electrical worker, inc. lineman	8.00 Day
Electrical worker helper	4.00 Day
Auto truck driver, 5 tons & up	35.00 Week
Auto truck driver, below 5 tons	30.00 Week
Teamster	25.00 Week
Laborer, 1st class (including working foreman, handy man and mechanics' helper not listed above)	.65 Hour
Laborer	.50 Hour

Time and one-half for overtime, double time for Sundays and holidays, except when otherwise stipulated, for monthly and weekly pay.

The Contractor shall file with the Commission, in such form and for such periods as the Commission shall stipulate, a record showing the name of all his employes, the hours worked, the wages paid to each and such other information as may be required.

If it shall be shown by the said record, to the satisfaction of the Commission, that a rate of wages more than 10 per cent in excess of the rate stipulated in the base scale has been paid for any of the above listed trades employed on this contract after December 31, 1920, and if said rates in excess of the base scale shall have been first determined by the Commission not to be unduly in excess of the then prevailing rates of pay on similar work, and are approved by the Commissios, then the Commission shall pay to the Contractor, in addition to the regular monthly estimate as provided in Arts. XXXI and XXXII a sum of money equal to the total amount of any such excesses of wages as have been actually incurred and paid after December 31, 1920, by the Contractor over said 10 per cent in excess of the base scale.

If on the contrary it shall be shown by the said record, to the satisfaction of the Commission, that a rate of wages 10 per cent or more below the base scale, has been incurred and paid in any of the listed trades during the period after December 31, 1920, then the Commission shall deduct from the net regular monthly estimates a sum of money equal to the total amount of any such differences betwen the rate actually paid by the Contractor and a rate 10 per cent below the base scale, or, if the Commission by its own investigation, after affording the Contractor an opportunity to be heard, shall find that the prevailing rates of pay on similar work for any of the listed trades are more than 10 per cent below the base scale, then the Commission may establish a new scale of wages predicated upon such prevailing rate and when such new scale is so established and copy thereof served upon the Contractor shall deduct from the succeeding monthly estimates, beginning thirty days thereafter, such sums of money as shall be equal to the difference between the rate 10 per cent below the base scale stated in the contract and the rates in said established new scale.

No extra payment shall be made for any trade or occupation other than those listed in the base scale

unless the employment of workmen or mechanics of said trades is approved by the Engineer and a base wage for such new trade or occupation has been established in writing by the Commission. The base wage for any new trade so established shall always be held to obtain for the calendar year within which established and no payments for increase thereof nor deductions for decrease therefrom, as provided herein, shall be made until and for the year or years following.

No payment will be made under this article for wages paid to any workmen who may be accounted for under the provision of Art. XIV. With respect to labor costs not covered by payments directly under items, no adjustments under this article shall be made.

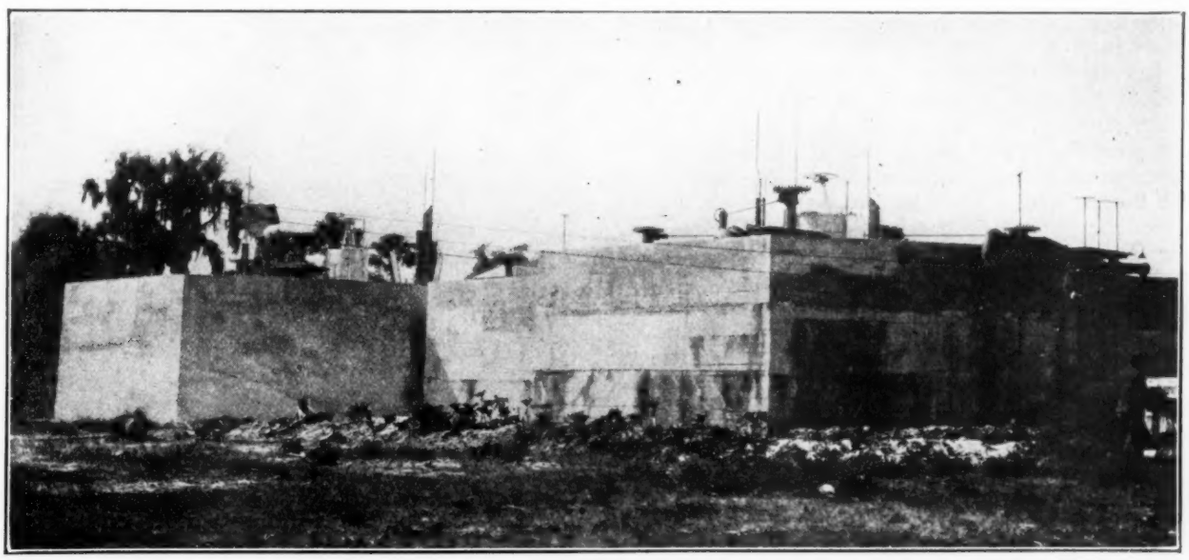
Article XXXI referred to provides for the customary monthly estimates, including in this an allowance for materials delivered on the site of the work at rates stated in the specifications; and Article XXXII provides for the payment of 90 per cent of the estimate within 30 days. Article XIV is one providing for extra work to be done at actual cost plus 15 per cent.

Water Softening in Florida

Hard, sulphur waters in Daytona and Palatka are aerated to release the sulphur gas and treated with lime, greatly improving them for domestic and boiler purposes. Artesian head of wells fills tanks in one city and partly fills them in the other, thus saving pumping.

About eleven years ago the Municipal Water Department of Daytona, Florida, installed a water softening plant to aid in improving the quality of the public supply, which plant was described by George A. Main in the October 11, 1911, issue of *Municipal Journal*. This plant operated satisfactorily, but with the improvement in the character of the water and the growth of the city, the consumption increased rapidly and the capacity of the plant was soon reached and exceeded, and three or four years ago the plant was doubled in capacity. The orignal plant contained three reinforced concrete hexagonal tanks with a total capacity of about 180,000 gallons, and an effective capacity of 150,000 gallons. The original tanks were built in horizontal sections, and there has always been more or less leakage through some of the horizontal joints between sections.

The new tanks are three in number and of the same shape and size as the old, but were built as monoliths, the concrete being poured into the forms continuously between five o'clock in the morning and nine o'clock of the following day. These tanks also are reinforced and can be filled to the full depth of 16 feet, giving them a capacity of 83,000 gallons. The tanks rest upon the ground surface, their walls extending entirely above the ground. In the center of each tank is a rising pipe and on top of this, about five feet higher than the top of the tank, is a horizontal table provided with a slotted raised edge of galvanized iron, which serves as an aerator, the water flowing through the slotted edge and in a circular cascade into the tank below. Water is forced through this riser pipe by a pump. In addition, there is an inlet pipe at the bottom of each tank which connects directly with the wells,



SEDIMENTATION TANKS OF WATER SOFTENING PLANT, DAYTONA.

The two lime-slaking tanks can be seen above the sedimentation tanks; also several of the aerating tables with their serrated edges. The old tanks are at the right, the new ones at the left.

AERATING WATER AT DAYTONA.

of which there are four, each 6 inches in diameter. The artesian head upon the wells is not sufficient to raise the water to the aerator, and the ordinary practice is to allow the tanks to fill about half full under the artesian head, when the water will begin to enter rather slowly. The remaining half is then filled by pumping from the wells through the riser and the aerator. The water is pumped into the tanks by a centrifugal pump rated at 1,000 gallons per minute.

The chief object of the aerator is to permit the escape of sulphur gases from the water, which is highly impregnated with sulphur, lime and magnesium. The aeration also results in the absorption of a certain amount of oxygen, and the result is a reduction in the amount of lime necessary to produce satisfactory softening. It is found that while 2.6 pounds of lime per thousand gallons is required for satisfactorily treating water introduced directly from the wells, 2.31 pounds is sufficient for water that has been pumped through the aerator; and it has been calculated that this saving in lime more than pays for the cost of pumping, the lift being only a few feet.

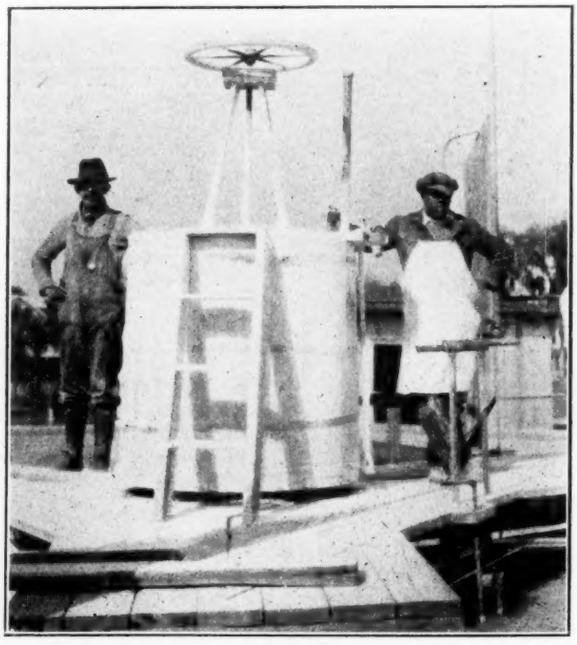
As told in the description of the original plant, the water is withdrawn from the tanks by a skimmer with float attachment. This consists of a pipe hinged, by means of a double elbow joint, to the outlet pipe in the bottom of the tank, and provided at its other end with a float which maintains the end of the pipe at a constant distance below the water surface, and also with a pan with a shallow rim which is so attached to the pipe as to be always approximately horizontal whatever the position of the hinged arm. Thus all the water is withdrawn from the surface and the lower water containing the sediment does not enter the mains.

The coagulation used is hydrated lime, the supply at the present being obtained from the Ohio Hydrate and Supply Company in 40-pound sacks, the cost of which a few weeks ago was 34 cents per sack. At the junction of each set of three hexagonal tanks, resting on the top of the wall, is located a lime slaking tank of wood, provided with a wooden paddle which is revolved by hand. About 600 gallons of water is run into one of these tanks, and the amount of lime required for the tankful of water is weighed on platform scales in the limehouse, and is dumped into the tank. This is then agitated by the hand-operated paddle until the lime is taken into solution. Before the lime water is run into the tank, air is admitted to the bottom of the tank through a grid of half-inch iron pipe laid in several lines across the bottom of the tank and provided with small holes. This thoroughly agitates the water, and when the entire tankful is boiling, the lime water is discharged from the lime tank. The paddles are kept going during the discharge, and when the tank is about three-quarters empty, water is allowed to run into and through it to wash out all of the contained lime. Air is applied for agitating the main tank for about an hour, securing a thorough intermixing of the lime water with that in the tank. The water in the tank is then allowed to stand for about twelve hours to settle, after which the water is drawn off into a clear-water basin, by means of the floating arm. The engineer believes that the result would be more satisfactory could the water stand for 24 or 36 hours, but this will be possible only if the plant is again doubled in size. The six tanks in use are treated in this way in succession. The clear water basin has a capacity of 74,000 gallons.

Lime and the suspended matter removed by it from the water collect in the bottoms of the tanks at the rate of about ½ inch per day. Each tank is cleaned out at intervals of from two to four weeks.

During the year 1919 the cost of aerating and purifying the water was $3,134, of which something over $2,000 was for lime. (The 1919 Annual Report does not itemize the several costs, but in 1918 the cost of aerating and purifying was $2,477, and during the same year the cost of lime was $1,794.)

In 1919 the cost of pumping was $5,118, as compared to $2,834 in 1918. In 1919 the cost of distributing was $518, as compared to $600 in 1918, and the overhead was $521, as compared to $735 in 1918. Plant repairs amounted to $2,142 in 1919 and $746 in 1918. In each year the interest on bonds was $2,500 and depreciation was charged at $1,900. In 1918, $5,863 as expended for salaries and wages, $1,616 for gasoline and oils, $250 for a



LIME SLAKING TANK, DAYTONA.

Ford truck and $2,210 for other materials and supplies, in addition to the lime already referred to. Adding $251 miscellaneous expenses and $762 refunding of meter deposits, etc., the total disbursements in 1918 were $12,746, while for 1919 the total was $18,567.

The pumping consists, in addition to operating the centrifugal pump for filling the tanks, of pumping the softened water from the clear-water basin into a circular steel tank 35 feet high, the bottom of which is 100 feet above the ground and the capacity of which is 75,000 gallons. In case of fire this tank is cut out from the distributing system and the pumps run the pressure up to between 85 and 95 pounds. The pumps used are Rumsey triplex plunger pumps, 12 inches in diameter and 14 inch stroke, operated by a 50 horse power Foos gas engine, 200 revolutions a minute This equipment is provided in duplicate. During the day the present consumption requires pumping about two-thirds of the time, and the pumps are run about two hours and are idle one hour. At night the pumps operate only about one-third of the time. During 1919 the amount pumped totaled 99,800,000 gallons.

There are about 1,200 services in the city, supplied by 922 taps. All of the consumers are metered. The population in summer is about 7,500, which is increased to between 10,000 and 20,000 during the winter.

For much of the above information and for courtesies shown at the plant we are indebted to Ben Tippins, the chief engineer of water works and sewers, and to F. J. Caldwell, first assistant engineer; also to E. L. Bond, Commissioner of Public Works.

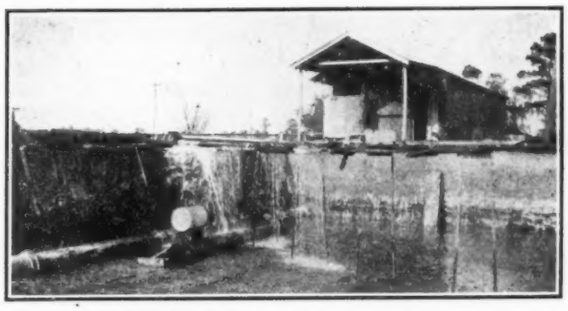
WATER SOFTENING AT PALATKA.

The well water used for the public supply at Palatka, Florida, is very similar to that of Daytona, and following the successful operation of the original Daytona plant, a similar plant was installed at Palatka for treating the water. The plant construction, however, is considerably different.

There are three rectangular reservoirs for sedimentation, each 65 feet square and 8 feet deep, and holding 225,000 gallons. All of the water is aerated when entering the tanks. The aeration is secured by causing the entering water to flow through troughs which are supported above the top of the tank on a line extending diagonally across it, each trough being provided with openings at intervals through which the water is discharged in numerous small streams into the tank.

There are two 4-inch wells, one 6-inch and one 8-inch, which give a head of 20 to 25 feet above the ground surface. The sedimentation tanks are partly below the surface, and pumping is not required or employed in filling them. These wells give a natural flow of something over 1,000 gallons a minute.

The lime water is mixed in a wooden tank located at the corner common to the three sedimentation tanks, and is discharged into which ever tank is desired. The three tanks form three equal quarters of a large square, the fourth quarter of which, under the lime-house, is occupied by a tank into



SOFTENING PLANT, PALATKA.
Lime house in background. In foreground, aerating trough, supported on steel horses. At left bottom, hinged discharge arm, with float.

which the sludge is withdrawn from the other three tanks. The water is agitated by compressed air admitted through a grid, the grid in each tank consisting of nine parallel lines of iron pipe laid in the bottom of the tank. After introducing lime and agitating, the water is allowed to stand seven hours before being drawn off into the clear-water basin, and this length of time appears to be satisfactory for this water. Each tank is cleaned about every 14 days, the sludge being withdrawn into the sludge tank and from this is washed into a stream. The hydrated lime used is obtained from the Florida Lime Company, and 1¼ pounds is used to a thousand gallons. In addition, there is used ¾ of a pound of soda ash 88 per cent, obtained from the A. S. D. Company.

From the clear-water basin the water is pumped to a stand-pipe which has a capacity of 500,000 gallons. The consumption varies from 400,000 gallons to 700,000 gallons a day. Two compound, triplex pumps with a capacity of a half-million gallons each were installed in 1906 by the John H. McGowan Company. The stand-pipe gives a pressure of 65 pounds in the center of the town, which is raised to 100 pounds in case of fire. Also, the pressure is raised to 100 pounds once a month as a test of the strength of the pipes, joints, house connections and other appurtenances Compressed air is furnished by an air compressor supplied by the Chicago Pneumatic Tool Company. Steam for the plant is furnished by two 75-horsepower boilers burning wood which were constructed by the R. D. Cole Manufacturing Company of Newnan, Georgia. Superheated steam is used.

William A. Lyon was the engineer for the installation of this plant, which was later enlarged by S. C. Stallings, who was city engineer until last September. The softening plant was installed by Mr. Stallings in 1916, the consulting engineer being George A. Main, superintendent of the Daytona water works and the designer of the softening plant for that city. The present chief engineer of the municipal water works plant is E. Usina, to whom we are indebted for the above information.

In addition to this municipal plant, there is a private plant which furnishes about half of the city's supply, or about 500,000 gallons a day on the average. This plant was constructed in 1886, and is still using the Worthington compound duplex pumps and Worthington boilers which were installed at that time. This is one of the very few

spring-water supplies in Florida. The supply seeps from low sand-hills into two gullies, down the bottoms of which it flows as surface streams into a basin. It passes through two sets of screens before entering the basin, and through two more screens between the basin and the pumps, by which all leaves, algae and other suspended matters are removed. This water is soft and receives no treatment. The basin is a shallow rectangular one with vertical brick walls. The water collected in this basin is raised to a standpipe. Pumping begins about 4.30 a. m. and continues to about 6.30 p. m., when the stand-pipe is left filled to provide the night consumption. The city has under consideration a proposition for purchasing this private supply.

A Good Roads Drive

Col. T. L. Kirkpatrick, president of the Charlotte-Ashville-Wilmington Highway Association, has appealed to all the North Carolina Good Roads leaders to join in a one-day drive to impress upon the Legislature the urgent need of a state wide system of permanent highways and demonstrate the public demand for them. This drive is expected to take the form of a convention meeting at Raleigh on the first day of the special legislative section about July 1.

It is intended to propose a $50,000,000 state bond issue, a $15,000,000 bond issue to pay for the portion of the Charlotte-Ashville-Wilmington Highway that traveres 16 counties of North Carolina, and a $1,000,000 bond issue by Mecklenburg County for renewing its macadam road system.

Road Material in Texas

The University of Texas has issued a report by Prof. J. P. Nash, Geologist with the Oil & Gas Department of the Texas Railroad Commission, that was primarily made to give details on road materials available for use in the U. S. Army in Texas, and extended to cover the entire state.

There are abundant supplies of gravel which has been largely used for the construction of mileage two or three times greater than that of any other type of road in this state. The most satisfactory gravel is found to contain between 60 and 70 per cent of pebbles between ¼ inch and 2 inches in diameter with sufficient sand to fill the interstices and a limited amount of clay for binder

There are many deposits of stone suitable for crushing that have not yet been thoroughly developed. There are deposits of granite in the central zone that can supply paving blocks suitable for heavy traffic, and there are many places where limestone with a coefficient of wear of more than ten and a compressive strength of more than 10,000 pounds per square inch can be procured.

For a distance of 100 miles from the coast, there are no natural deposits of satisfactory road materials so that first-class highways involve importing materials.

There are deposits of the best limestone and of granite and gneiss running in a north and south direction through the center of the state, gravel deposits in the river beds in the southwestern part of the state, trap rock, limestone and gravel in west Texas, but no good road material in and south of the Panhandle territory.

The Cost of Road Building

The latest advices from different sections of the country indicate that the promised reduction of high prices has not yet materialized in road building operations at least. In Chicago, it is estimated that the $60,000,000 bonds authorized by the state of Illinois will complete only one-third of the work originally planned. The present contract prices for new work average $42,000 per mile or 50 per cent in excess of the average contract prices a year ago, with the probability that this is a minimum and the cost will raise to $50,000 before the completion of the work.

In Dallas County, Texas, the commissioners have found that the highway system carefully estimated a year ago at $6,500,000 cannot be built now for anywhere near that sum, and that in Wichita County, roads that cost $40,000 per mile last year will cost about $70,000 this year, making the $2,000,000 bond issue that has been voted entirely inadequate for the system of concrete roads it was intended to construct. It is feared there that the effect of these costs will be a temptation, in order to secure the proposed mileage, to build new roads inferior in quality to those originally planned, which would be deplorable In both Texas and Illinois, it is recommended to defer extensive road building until conditions are more settled and exorbitant costs are reduced.

John W. Budd, superintendent of streets, Des Moines, states that the cost to property owners for paving was 72 per cent greater in 1919 than in 1910, and 63 per cent greater than in 1917 The costs per yard for each year from 1910 to 1919, inclusive, are respectively $2, $1.81, $1.75, $1.78, $1.94, $2.11, $2.57, and $3.45, showing the rapid increase to have occurred since the war.

In New Jersey, on March 22, Major F. A. Reimer, county engineer of Essex county, recommended to the County Board of Freeholders that all plans for new road construction be abandoned for the present year, although in January he had presented a program involving the expenditure of nearly $820,000. His reason was that, on the basis of prices now prevailing, new construction would cost approximately $10,000 a mile more than in 1919, or about 25 per cent. This deferring of new construction is possible because all the main highways are in excellent condition, and the main tributaries are of telford macadam in good condition. These can be maintained satisfactorily for $340,000.

Hydro-Electric Power for New Zealand

On account of the great difficulty in importing coal, the government of New Zealand has passed an act encouraging the development of hydro-electric power and has purchased a plant near Auckland, capable, with slight improvements, of developing about 12,000 h. p. Another plant, capable of producing 8,000 h. p., is now in operation and plans have been made for the developing of 160,000 more h. p., and it is hoped to provide sufficient hydro-electric power to make the country independent for manufacturing purposes.

NEWS OF THE SOCIETIES

April 7. — NATIONAL IMMIGRATION CONFERENCE, at Engineering Societies Building, New York City. Chairman of Board of Inter-Racial Council, Coleman du Pont, 120 Broadway, New York City.

April 12-17. — UNITED STATES GOOD ROADS ASSOCIATION. Eighth Annual Convention, Hot Springs, Ark. Director-General, J. A. Rountree, 1021 Brown-Marx Building, Birmingham, Ala.

April 16-17. — BANKHEAD NATIONAL HIGHWAY ASSOCIATION. Fourth Annual Convention, Hot Springs, Ark. Secretary, J. A. Rountree, 1021 Brown-Marx Building, Birmingham, Ala.

April 27-29—CHAMBER OF COMMERCE OF THE UNITED STATES. Eighth annual meeting, Atlantic City.

May 4-6.—NATIONAL FIRE PROTECTION ASSOCIATION; Chicago. Secretary, 87 Milk street, Boston.

May 10-11.—AMERICAN ASSOCIATION OF ENGINEERS. Sixth Annual Convention, St. Louis, Mo. Secretary, C. E. Drayer, 63 East Adams Street, Chicago.

May 13-14-15.—LEAGUE OF TEXAS MUNICIPALITIES. The eighth annual convention will be held at Dallas, Tex. Secretary-Treasurer, Frank M. Stewart, University of Texas, Austin, Texas.

May 18-21.—NATIONAL ELECTRIC LIGHT ASSOCIATION. Annual convention, Pasadena, Cal. Acting Secretary, S. A. Sewall, 29 West 39th Street, New York City.

June 22. JOINT COMMITTEE ON STANDARD SPECIFICATIONS FOR CONCRETE AND REINFORCED CONCRETE. Next meeting at Asbury Park. Secretary-treasurer, D. A. Abrams, Lewis Institute, Chicago.

June 21-25.—AMERICAN WATER WORKS ASSOCIATION. Annual meeting, Montreal, Canada. Secretary, John M. Diven, 153 West 71st Street, New York City.

June 22-25.—AMERICAN SOCIETY FOR TESTING MATERIALS; Asbury Park, N. J. Office of secretary, Philadelphia.

Aug. 30-Sept. 3.—AMERICAN PUBLIC HEALTH ASSOCIATION; San Francisco. Office of secretary, Boston.

Oct. 4-8. — AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention, St. Louis, Mo. Secretary, Charles Carroll Brown, 404 Lincoln Avenue, Valparaiso, Ind.

American Railway Engineering Association.

The 21st annual convention at Congress Hotel, Chicago, March 16th-18th had a record attendance of 561 and received reports from 22 regular, and two special committees. The most important action was the adoption of new specifications for iron and steel structures and for steel rails. Among other important reports received were those of the track committee with new plans for frogs and switches; the railway location and operation committees' reports dealing with new punitive overtime rates of pay, and the reports of committees on yards and terminals containing specifications for track scales which were adopted.

Among the important topics discussed, were the use of twisted bars for concrete reinforcement which was strongly opposed, a system of training young engineers in railway service; treatment of timber by creosote processes; the shrinkage of earth fills and the settlement of surface under fills; the loading of telegraph and telephone poles; the conservation of materials and human energy, and the compulsory adoption of the metric system, which was opposed.

H. A. Safford was elected president, and the members attended an annual dinner addressed by several prominent speakers.

May 13-14-15, League of Texas Municipalities.

The eighth annual convention will be held at Dallas, Tex. Secretary-Treasurer, Frank M. Stewart, University of Texas, Austin, Texas.

National Federation of Construction Industries.

The first annual meeting of the federation was held at Hotel Sherman, Chicago, March 24-25 and was notable as the first meeting of a regularly constituted business organization representing the entire construction industry and includes about 200 national associations, which together with the affiliated interests, have a normal annual production of about $3,000,000,000 worth of permanent taxable wealth, including more than one-fourth of the railroad tonnage of the United States. The federation was created in July, 1918, as the result of the request of the war industries board to the chamber of commerce of the United States to organize the construction industries into a single war service committee. In the beginning of 1919, it was decided to reorganize it on a permanent basis.

Among the important subjects considered at the convention were the proposed division of the United States into twelve federal districts, co-terminous with the federal reserve districts, each with an executive committee with a vice-president of the federation serving as chairman and having authority to deal with construction problems locally. Other matters brought up for consideration were freight traffic, standardization in the construction industry, foreign trade, financial operation, industrial relations, jurisdictional awards and Americanization.

In a service letter calling the annual meeting and addressed directly to about 30,000 business men, it was stated that the federation has been formed for the purpose of extending construction and improving conditions in the construction industry. It is intended to co-ordinate the several divisions of the industry. In the accomplishment of these results the objects of the Federation will be:

To promote close coo-perative relations between producers, manufacturers, distributors, contractors, architects, engineers, realtors, financiers and other construction interests; to develop and preserve satisfactory conditions in the relationship of the combined industry to the general public, including the Government, labor and consumers; to serve as an exchange between and common meeting place for associations representing social construction interests;

In cases where a special construction interest is primarily concerned to support the initiative of the representative association in all matters considered by the federation to be within the proper scope of its activities; in cases of common interest to the construction industry in general to take the initiative in investigation, policy, propaganda, legislation, and in such other ways as will benefit the industry; and to provide a united organization which will mobolize the entire strength and experience of the industry.

Immigration Conference.

A national immigration conference will be held April 7th in New York City in the Engineering Societies Building, 29 West 39th street, New York.

National leaders in American industry and finance will discuss the shortage of foreign born labor and the loss of production due to unrest among the workers, and measures will be taken for united action to relieve this condition.

Invitations to attend this conference have been issued by the Inter-racial Council to more than a thousand of the directors of industrial concerns, especially those employing foreign born labor, and to others who are interested in this problem from the standpoint of finance on national welfare including racial leaders. All industrial executives are invited to be present.

Topics to be discussed will include pending bills on immigration, and a constructive policy will be preposed and voted upon.

PERSONALS

Dewey, E. P., has been made city engineer of Pasadena, Cal.

Kellog, R. N., has been appointed highway engineer of Wallowa County, Oregon.

Orbison, R. V., has become city manager of South Pasadena, Cal.

Steebergen, William, has been made road engineer of Jackson County, W. Va.

Keyes, R. D., has been appointed construction engineer in San Diego County, Cal., for the State Highway Commission.

Nelson, C. L., has been elected city engineer of Muskegon, Mich.

Hall, Roy F., has been appointed division engineer of the New York State Highway Commission with headquarters at Watertown.

Shields, J. R., has been appointed special assistant engineer of the public works commission, Sacramento.

Early, J. B., has been appointed resident engineer of Foard County, Texas.

Blum, Weldin & Co. has been appointed consulting engineer to the Comptroller of Alleghany County, Pa.

Logan, Spencer, has been appointed city engineer of Coffeyville, Kans.

Crotty, C. C., has been appointed assistant court director of Houston, Texas.

Heindle, W. L., formerly superintendent of the Wilmington & Philadelphia Traction Co., has opened an office for engineering and contracting at Wilmington, Del.

Solomon, G. R., has been elected vice-president of the Fuller Engineering Corporation, New York.

McComb, D. W., has been appointed division engineer of the Tennessee Highway Department of the United States Bureau of Public Roads.

Lund, A. M., has been elected president of the Little Rock, Arkansas, Engineers' Club.

Barnes, W. T., has become chief engineer of the Spring Brook Water Supply Co., Wilkes-Barre, Pa.

Sheerer, C. E., and Miller, J. H., have formed the Sheerer-Miller Structural Engineering firm in Memphis, Tenn.

Dilling, A. W., has been appointed engineering assistant to the commissioner of public works, Chicago.

Safford, Harry R., assistant to the president of the Chicago, Burlington & Quincy Railroad, has been elected president of the American Railway Engineering Association.

Warren, G. E., has resigned his position as assistant manager Service Bureau of the Universal Portland Cement Co., Chicago, taking effect April 1, 1920, to continue his duties as manager of the American Concrete Pipe Association. Mr. Warren has been with the Service Bureau of the Universal Co. for five years during the last year of which he has also acted as secretary-treasurer of the American Concrete Pipe Association.

Allen, T. H., city commissioner of Memphis, Tenn., has developed a new system of garbage disposal for separating garbage, ashes and rubbish.

Baldwin, Ward, was elected president of the Cincinnati Association of the American Society of Civil Engineers which after two years was resuscitated last month.

Black, Russel V., has been appointed assistant engineer to the City Planning Commission, Akron, Ohio.

Turner, Geo. F., has been appointed city engineer of Youngstown, Ohio.

Lillie, F. M., has been appointed consulting engineer to the city of Youngstown, Ohio.

Percival, F. M., has been appointed engineer of Aransas County, Texas.

Spooner, J. P., Jr., has been appointed engineer in charge of highway maintenance for San Joaquin County, Cal.

Caldwell, W. G., has been appointed highway engineer of Waukesha County, Wis.

Buttes, C. M., has been appointed chief engineer for the $1,800,000 new highway for Butte County, Cal.

Stowitz, G. P., has been appointed chief engineer of the Lord Drydock Co., West New York, N. J.

Freer, F. C., has been appointed county engineer of Douglas County, Oregon.

Ireland, Col. Mark L., of the Motor Transfer Corp., U. S. A., has been appointed a member of the National Research Council Committee on Economic Theory of Highway Improvement.

Boyd, J. C., first vice-president of Westinghouse, Church, Kerr & Co., Inc., will open an engineering office in New York.

Crowe, F. T., recently project manager of the Flat Head Irrigation Project, has become associated with Rich & Markhus, contractors, of Prosser, Washington.

Burgraff, C. I., has been appointed bridge engineer with the Morgan Engineering Co., Memphis.

Johnson, Col. George A., will be the head of the firm of Johnson & Denham and will direct the design, construction, supervision and management of water supply, sewage and other public utilities.

Hamm, R. C., has been appointed engineer of Fort County, Kansas.

Cunningham, Max. L., has been made vice-president and chief engineer of the Municipal Excavator Co., Oklahoma City.

Murray, Joseph A., Jr., has been appointed principal assistant engineer, bureau of engineering, Albany, N. Y.

Ohrt, Fred, has been appointed city engineer of Honolulu, succeeding Wilson, John H., who has been elected mayor of the same city.

Lough, Thomas, has been appointed assistant state engineer, North Dakota Highway Commission.

Prann, C. P., has been appointed city engineer, Meridan, Ct.

Drinkwater, Ernest, has been appointed city engineer of St. Lambert, Canada.

Carman, E. S., president, Cleveland Engineering Society, addressed the Mohawk Valley Engineers' Club at Utica, March 18, on the industrial situation in the United States and Europe.

Brandow, Emory E., has been made bridge engineer for the New York State Highway Department.

Cooke, Charles W., sales manager and assistant general manager of the Acme Road Machinery Co., died at Beaver Falls, Pa., March 2nd.

De Forest, Edgar A., industrial engineer, delivered an address, March 25th to the Brooklyn Engineers' Club reviewing some remarkable developments in the efficient application of power and illustrated a number of new features in the elimination of power losses.

Lee, W. S., vice-president and chief engineer of the Southern Power Co., will also engage in general consulting practice, specializing in hydro-electric work with offices in Charlotte, N. C., and in New York City.

Stimson, Earl, chief engineer of maintenance, Baltimore & Ohio Railroad, and president of the American Railway Engineering Association, stated at the recent Chicago Railroad Convention that the present railroad problems are those of maintenance rather than of construction.

Reeves, Austin H., has opened a consulting engineer's office at Charlotte, N. C.

White, Lieut. Col. R. M., has been appointed superintendent of the Morris & Essex Division of the Delaware, Lackawanna & Western Railroad, with office in Hoboken.

Lane, F. M., has been appointed engineer of the Woodland Diking District, Cowlitz Co., Washington.

Trimble, R. D., with Winston & Co., Richmond, Va., has resigned and has organized the engineering, consulting and constructing firm of R. D. Trimble & Co., Richmond.

New Appliances

A New Bucyrus Shovel

Combines Revolving Shovel, Dragline Excavator, Clamshell Excavator and Locomotive Crane.

The Bucyrus Company's new revolving shovel 30-B, which supersedes 18-B ⅞-yard revolving shovel, has been carefully designed as a universal machine to be used as a revolving shovel, or with the addition of a few extra parts, as a dragline excavator, a clamshell excavator, a locomotive crane, and with a long boom and dipper stick for excavation requiring unusually high lift, in all of which capacities it is available with the minimum of labor, delay and expense, and is designed for 100 per cent efficiency.

When used as a revolving shovel, it carries a 1-yard dipper, having a capacity of 1-yard water measure and 1¼ yards heaped up. It can be mounted on either caterpillar traction, traction wheels or railroad trucks of any gage from 3 feet 3 inches to 5 feet. According to the mounting, the working weight varies from 29½ to 34 tons. It is adapted to the purposes of ordinary contract work including cellar and road excavation, and yet is sufficiently rugged and powerful for operations in clay pits, rock quarries, mining and stripping.

It will operate a 1-yard clamshell bucket on a 35-foot boom or a ¾-yard bucket on a 40-foot boom when provided with additional drum and operating mechanism. These parts, supplemented by a hoisting hook, also enable it to serve as a locomotive crane with a capacity of 9¾ tons at 20 feet radius, with caterpillar traction, and 9 tons on car trucks or tractor wheels.

The equipment for clamshell excavation suffices for dragline operations when supplemented with a suitable drag bucket and line.

For sewer excavation, the machine may be used either with a 30-foot dipper handle adequate for digging a trench 20 feet deep or with a 24-foot handle for a 14-foot trench. The dipper has an unobstructed cutting edge for the corners as well as for the front of the dipper. For exceptionally high lifts, a 26-foot boom and 17-foot dipper handle can be supplied.

The improvements in their design include very rigid construction; accessible steam plant, engines, and machinery; simplified operating lever arrangements; and reduction in the number of working parts.

The caterpillar mounting is strongly recommended to save time and labor, making it possible to move the shovel readily from one job to another without requiring a large force of men. It permits the shovel to back away from blasts without loss of time and to operate in flooded pits where ordinary plant would be idle. With it, the shovel can travel over soft ground and climb steep grades with ease. The caterpillar mounting has no complicated side frames and has eliminated the use of chains in the driving mechanism. The treads are of cast steel with smooth bearing surfaces suitable for travel over city streets, pavements and improved roads without injurying them. The machine can be easily turned in its own length. It is described in Bulletin C-301.

Excavating and Self-Loading Motor Truck

United States patent 1,320,970 was issued November 4, 1919, to E. L. Beaty for a combination of excavating and loading device with a motor truck that provides equipment especially recommended for road building. Pivoted near the center of the truck frame is a horizontal yoke revolving clear of the frame, outside of it, and carrying clear of the front part of the truck, a scraper-like tilting bucket that may be set with the lower side horizontally supported on the surface of the road so that when the truck advances it will be pushed forward and the cutting blades will engage the earth and fill the bucket. The truck driver controls a crank shaft driven by the truck motor that revolves the yoke so as to carry the filled bucket over the engine and front part of the truck and dump it into the truck body in the rear after which the bucket is returned to excavating position, and so on.

This apparatus is intended to entirely eliminate hand work in light excavation and in loading the spoil.

Any make of truck can be equipped with this power shovel which, on a 3½-ton truck with a 3-yard dump body will, it is claimed, do more and better work than the same truck without the power shovel requiring a force of ten laborers to excavate and load it. With hauls varying from ¼ mile to 2 miles, the use of hand labor for operating the truck involves a loss of from 33 to 75 man-hours per day occasioned by idle time when the men are waiting for the truck to arrive.

An Automatic Discharge Counter

The W. & T. Automatic Discharge Counter sold by Wallace & Tiernan Co., Inc., has been developed to record the application of sewage from dosing chambers to sprinkling filters or contact beds at sewage treatment works. Wherever it is desired to have a record of the number of fillings of a tank this device is applicable, as for water tanks, flush tanks, syphon chambers, chemical solution tanks.

The device consists substantially of an inverted air bell submerged with its bottom just above low level of the syphon tank and provided with a flexible air connection. From the top of the bell is a diaphragm actuating the simple counting and recording mechanism, located at any convenient place.

The Clark Truck Tractor

The Clark truck tractor, designed and built by the Clark Trucktor Co. for contracting service, consists of a 3-wheel steel truck weighing 2,450 pounds and provided with a 25 h. p. four-cylinder engine. It has a speed of ½ mile to 12 miles per hour and an automatic dump body with a capacity of 27 cubic feet of dry or 18 cubic feet wet.

It is very compact with drivers' seat over the engine, and is especially recommended for use in paving, road building and other work where it is found very convenient for hauling buckets of concrete, sand, gravel, earth or other materials.

INDUSTRIAL NEWS

Portland Cement Association.

C. N. Reitze, formerly district engineer of the Seattle office of the Portland Cement Association, has been appointed district manager of the Pacific coast offices of the association at Seattle, Portland, San Francisco and Los Angeles. Since May, 1916, Mr. Reitze has been district engineer in charge of the Seattle office of the association and temporarily will be located in Seattle, although later in San Francisco.

A. P. Denton, formerly district engineer of the Dallas office of the association, assumes charge of the San Francisco office as district engineer.

Charles A. Clark is appointed district engineer of the Dallas office of the association, effective March 15, to succeed A. P. Denton. Mr. Clark has been in the employ of the

association since 1917, serving in various capacities in the field and at association headquarters.

H. E. Frech will assume charge of the St. Louis office of the association as district engineer, effective April 1. For two years immediately prior to coming with the association, Mr. Frech was city engineer of Hannibal, Mo.

The Asphalt Association.

Permanent headquarters for The Asphalt Association, an organization representing the producers and users of asphalt for paving purposes, have been established in the new National Association Building, 25 West 43rd street, New York City.

From its main headquarters and its branch offices at Washington, Chicago and Toronto, The Asphalt Association will continue its educational and research work, looking to extension and development of asphaltic types of highway construction along the most effective engineering and economic lines.

J. R. Draney, of the United States Asphalt Refining Company, is president of the association; W. W. McFarland, of the Warner-Quinlan Company, is vice-president; Herbert Spencer, of the Standard Oil Company of New Jersey, is treasurer, and J. E. Pennybacker, formerly chief of management of the United States Bureau of Public Roads, secretary.

The Blaw-Knox Company.

O. O. Olstad, formerly connected with the New York office, has been made manager of the New England territory, with offices in the Little Bldg., Boston, Massachusetts, succeeding A. W. Ransome, who has been appointed manager of the Pacific Coast territory, with offices in the Monadnock Building at San Francisco.

A. W. Ransome, formerly manager of the New England territory, with offices at Boston, Massachusetts, has been transferred to San Francisco in the capacity of manager of the Pacific Coast territory with offices in the Monadnock Building, San Francisco.

Mr. Ransome was born in San Francisco, and is a graduate of the University of California, Class of 1897. He played fullback on the University Eleven for four years, captaining the team of 1896. Immediately after leaving college, Mr. Ransome became engaged in the construction machinery business, until 1917, when he became associated with the Blaw-Knox Company.

Kentucky Rock Asphalt Specifications.

These specifications are issued by the Kentucky Rock Asphalt Co., in order to secure the best results for the public from the use of the asphalt, and the company reserves the right for its engineers or representatives to inspect and advise at any time for the best results.

The specifications are written under several heads including the original construction of crushed limestone, granite or slag, the base course, construction methods and materials, top course, roughened surface, reconstructed pavements, notes on the resurfacing of brick pavements and various clauses concerning city pavements, railway tracks, gutters, manholes, shoulders and crowns.

Engineering Company Incorporates.

The Haddow Engineering Co., of Tacoma, recently filed articles of incorporation, naming a capitalization of $25,000. Incorporators are: Robt. Haddow, Jr., Bert Hall, et al. The concern will do a general engineering and contracting business.

Waterworks and Sewage Disposal.

J. W. Frazier, J. W. Ellms and R. E. Sheal announce the incorporation of The Frazier-Ellms Sheal Company for the purpose of conducting a general engineering business in the design and construction of waterworks, pumping and power plants, water purification and sewage disposal plants, sewer and drainage systems and buildings. The company is also prepared to conduct engineering investigations, prepare reports and make appraisals.

The active members of the company have been engaged for many years in consulting engineering work, but along the lines of their individual specialties. By combining their varied experience and special training, they are able to offer highly trained technical service in a wide field.

The offices of the company are in the Illuminating Building, Cleveland, Ohio.

The Road to Camp Knox.

A handsome pamphlet describes the production and preparation of Kentucky rock asphalt and its use in road building. Another little booklet, entitled "The Road That Carries the Load," gives further information on the same subject and is also published by the Kentucky Rock Asphalt Co.

The Concrete Dope Book.

This booklet, issued in the interest of the Winard Model concrete hoists and Winard water tanks and pumps, gives specifications and illustrations supplemented by an equal number of pages of interesting data concerning ordinary concrete construction, such, for instance, as materials and proportions required for 100 square feet of concrete sidewalks, floors, or plaster work; notes on making and setting foundation forms; prices of various concrete constructions, concrete blocks, and other information.

The Barber-Greene Company.

This company is now represented in St. Louis by R. E. Foulke, 404 3rd National Bank Bldg.; Pittsburgh by J. A. Gurney, 605-606 Arrott Bldg.; Philadelphia by F. S. Sawyer, 1010 Penn Square Bldg., and Indianapolis by W. T. MacDonald, 305 Merchants Bank Bldg.

These are direct Barber-Greene branches and the representatives experienced engineers, well qualified to furnish true service and engineering advice to all individuals and firms having material handling problems, especially those involving the installation of Barber-Greene Self-Feeding Bucket Loaders, and Barber-Greene Standardized Belt Conveyors.

T. L. Smith Opens Eastern Offices.

The establishment of a T. L. Smith Company New York office and warehouse has been long contemplated and is an important item in the general expansion of the Smith organization.

E. R. Marker has taken over this New York office's big showroom space on the ground floor of the Hudson Terminal Building at 50 Church street. Shipments of all sizes of mixers, pavers, pumps, as well as all repair parts will be made directly from the Eastern Warehouse, located at 122 Lilly street, Newark, N. J. Mr. Marker for four years had charge of the Milwaukee district office and for the following three was sales manager, operating through the Milwaukee office. Under his direction the sales of the company have increased over 150 per cent.

Combination of Two Large Engineering and Construction Companies.

The combination is announced of the organizations of Westinghouse, Church, Kerr & Co., Inc., Engineers and Constructors, New York, and Dwight P. Robinson & Co., Inc., constructing and consulting engineers, of New York.

The new company will be called Dwight P. Robinson and Company, Inc., and will occupy executive offices at 61 Broadway and engineering and designing offices in the Grand Central Palace, 125 East 46th street, New York.

Dwight P. Robinson—president of the new company—was for many years president of the Stone & Webster Engineering Corporation, and in 1918 formed his own company.